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# BULLETINS
OF
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## VOL. XV

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55
56
57
57a
57b
58

Harris Co.
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# CONTENTS OF VOLUME XV

| Number | | Plates | Pages |
|---|---|---|---|
| 55. | **A Lower Tertiary Fauna from Manta, Ecuador** ......<br>*By J. J. Galloway and Margaret Morrey* | 1 - 6 | 1 - 56 |
| 56. | **Three New Claiborne Fossils** ................................<br>*By W. S. Cole* | 7 - 8 | 57 - 66 |
| 57. | **Contributions to the Tertiary Paleontology of Peru : Part 2, Upper Eocene Mollusca and Brachiopoda** ...<br>*By A. A, Olsson* | 9 - 16 | 67 - 116 |
| 57a. | **A New Oligocene Brachiopod from Mexico**........ ..........<br>*By W. S. Cole* | 17 | 117 - 122 |
| 57b. | **Some Small Foraminifera from the Meson Formation of Mexico**.......................................................<br>*By W. S. Cole and Ruth Gillespie* | 18 - 21 | 123 - 142 |
| 58 | **Higher Fossil Faunas of the Upper Allegheny**.........<br>*By Kenneth E. Caster* | 22 - 80 | 143 - 316 |

SMITHSONIAN INSTITUTION

BULLETINS
OF
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Vol. 15

## No. 55

# A LOWER TERTIARY FORAMINIFERAL FAUNA FROM MANTA, ECUADOR

By J. J. Galloway and Margaret Morrey
Columbia University, New York, N. Y.

*January 3, 1929*

Harris Co.
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# INTRODUCTION

The Foraminifera described and figured in this paper were collected near Manta, Ecuador, by Mr. M. N. Bramlette, of the South American Gulf Oil Company, which company has kindly given permission for the fauna to be published. The material was collected from a silty shale at the surface, and all the species are from the same sample. Many of the more fragile specimens have been broken in collecting or washing.

The fauna is of special interest in being the third and largest occurrence of small Foraminifera to be described from South America. One species was described by Bornemann, from the Tertiary of Rio de Janeiro[1], and twenty-five species were listed and five species and one variety described by Berry from Peru.[2].

There are included in this paper eighty-eight species and varieties, belonging to thirty-nine genera. There are ten new species and one variety. It is remarkable, in view of the fact that so few small fossil Formanifera have been described from South America, that there are so few new species in the Ecuador fauna. The identifications have been made with extreme care, and in all cases where identifications have been made the Ecuador specimens are almost identical with the published figures. The specimens have been compared in all cases, excepting that of *Quinqueloculina angusta* (Philippi), with the original figures and descriptions. The international Rules of Zoological Nomenclature have been strictly adhered to. In cases where the names or definitions of genera are not agreed upon by recent authorities, the synonymies and descriptions of the genera are included. The classification is that of the senior author.

The age of the fauna is not known to us except by what the Foraminifera themselves indicate. The age cannot be told by the percentage of like species which have been reported from different horizons. The type specimens of the species with which the Ecuadorean species have been identified came from the following horizons: 11 from the Eocene, 15 from the Oligocene, 12 from the Miocene, 17 from the Pliocene, 1 from the Pleistocene, and 18 from the Recent. On the basis of specialized forms, such as *Nodosarella camerani* (Dervieux), the age is upper Eocene. The fauna bears greatest resemblance in general to the following described faunas: Eocene and Lower Oligocene of Hungary, described by Hantken; Upper Eocene of Texas, described by Cushman and Applin; Lower Eocene of Texas, described by Mrs. Plummer; Upper Eocene of Mexico, described by Cole; and Pliocene of Kar Nikobar, described by Schwager. There are no well known guide fossils, such as the orbitoids and nummulites.

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[1] Bornemann, in Erman's Archiv Wiss. Kunde Russland, vol. 14, 1855, p. 153, pl. 1, figs. 5-15.

[2] Berry, Eclogae Geol. Helvetiae, vol. 21, no. 1, 1928, p. 130, figs. 1-6.

On the whole, we judge the fauna to be Upper Eocene in age.

## SYSTEMATIC DESCRIPTIONS

### Family MILIOLIDAE d'Orbigny, 1846

### Genus QUINQUELOCULINA d'Orbigny, 1826

**Quinueloculina angusta** (Philippi) Plate 3, fig. 3

**Triloculina angusta** Philippi, Tertiar. nordwest. Deutsch., 1843, p. 43, pl. 1, fig. 40.

**Quinqueloculina angusta** Reuss, Sitz. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 18, 1856, p. 253, pl. 9, fig. 90. (Upper Oligocene.)

Test elongate, elliptical, one side flat, the other inflated; chambers well marked, round in section; sutures depressed; surface smooth; aperture at the end of a short neck, round, without tooth. Length, 0.5 mm.; breadth, 0.23 mm. Abundant.

### Genus SIGMOILINA Schlumberger, 1887

**Sigmoilina celata** (Costa) Plate 3, fig. 4

**Spiroloculina celata** Costa, Mem. Accad. Sci. Napoli, vol. 2, 1855 (1857), p. 126, pl. 1, fig. 14; Atti Accad. Pontiana, vol. 7, fasc. 2, 1856, no description, pl. 26, fig. 5. (Pliocene.)

**Planispirina celata** Brady, Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 197, pl. 8, figs. 1-4. (Recent.)

Test subelliptical in side view, the ends somewhat pointed; unequally biconvex; chambers very little inflated, about five on a side; sutures obscure; wall thin, covered with fine sand grains; the interior is smooth; aperture terminal, round, or closed with sand grains. Length, up to 0.93 mm. Abundant.

The wall is very thin and the wall of the last chamber is either broken out or uncompleted in all our specimens, and the apertures are closed.

### Family GLOBIGERINIDAE Carpenter, 1862

### Genus GLOBIGERERINA d'Orbigny, 1826

**Globigerina bulloides** d'Orbigny Pate 3, fig. 5

**Globigerina bulloides** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 277, no. 1; Modèles, no. 17 and no. 76; Voy. Amér. Mérid., vol. 5, pt. 5, 1839, p. 37; in Barker, Webb and Bertholet, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foram., 1839, p. 132, pl. 2, figs. 1-3, 28. (Recent.)

Test composed of about ten globular chambers, rapidly enlarging, four in the last whorl; sutures deep; wall thick, coarsely perforate; surface reticulate; aperture an elongate slit opening into the umbilicus. Length, 0.28 mm.; breadth, 0.23 mm. Common.

**Globigerina compressa** Plummer Plate 3, fig. 6

**Globigerina compressa** Plummer, Univ. Texas, Bull. 2644, 1926 (1927), p. 135, pl. 8, fig. 11 a-c. (Eocene.)

Test rotaliform, unequally biconvex, the ventral side more convex than the dorsal; periphery lobulate; peripheral margin subangular; chambers inflated, six in the last whorl; sutures depressed, curved on both sides of the test; wall hyaline, medium coarsely perforate; surface granulate, aperture on the ventral side, at the base of the last chamber, extending from the umbilicus nearly to the periphery, with slight lip. Diameter, 0.2 mm. Rare.

Our specimens are not as compressed as the Texas form, but otherwise they are very similar.

**Globigerina conglomerata** Schwager Plate 3, fig. 7

**Globigerina conglomerata** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 255, pl. 7, fig. 113. (Pliocene.)

**Globigerina bulloides** var. **quadripartita** Koch, Eclogae Geol. Helvetiae, vol. 19, pt. 3, 1926, p. 745, text fig. 20. (Middle Tertiary.)

Test globular, high spired; chambers elongate dorso-ventrally, inflated, the last one smaller than the penultimate, and usually depressed, four in the last whorl, forming a restricted, rectangular, deep, straight-sided umbilicus or vestibule; sutures deep; wall coarsely perforate and granulate; aperture opening at the bottom of the vestibule, not generally visible from the exterior. Length, up to 0.7 mm. Abundant.

This species differs from the Pleistocene *G. quadrilaterata* Galloway and Wissler (Jour. Pal., vol. 1, 1927, p. 44) in the larger size, elongate chambers, higher spire, and deep vestibule.

**Globigerina pseudobulloides** Plummer Plate 3, fig. 8

**Globigerina pseudo-bulloides** Plummer, Univ. Texas Bull. 2644, 1926, (1927), p. 133, pl. 8, fig. 9. (Eocene.)

Test oval in dorsal view, consisting of about nine inflated chambers, five chambers in the last whorl; spire depressed; sutures deep; wall coarsely perforate and granulate; aperture slit-like, extending from the umbilicus toward the periphery. Length, 0.33 mm.; breadth, 0.27 mm. Abundant.

This species is related to *G. cretacea* rather than to *G. bulloides.* It differs from *G. cretacea* in not having the aperture in the umbilicus, and from *G. bulloides* in having more chambers in a whorl, the chambers enlarge less rapidly, and the aperture is not in the umbilicus. ,

**Globigerina trilocularis** d'Orbigny Plate 3, fig. 9

**Globigerina trilocularis** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 277, no. 2.—Fornasini, Rendi Sess. R. Accad. Sci. Isti. Bologna, n. s., vol. 2, 1898, p. 12, fig. 2, pl. 1, figs. 6-7. (Pliocene.)

Test composed of about seven or eight globular chambers, three or three and a half in the last whorl, the last chamber nearly as large as the remainder of the test; spire depressed; sutures deep; wall coarsely perforate and granulate; aperture an arch opening into the umbilicus. Length, up to 0.4 mm. Common.

This species differs from *G. triloba* Reuss in not having accessory dorsal apertures. It differs from *G. bulloides* in having only three chambers in the last whorl.

### Family LAGENIDAE Reuss, 1861

### Genus LENTICULINA Lamarck, 1804

**Lenticulina occidentalis novangliae** (Cushman) Plate 1, fig. 1

**Cristellaria occidentalis** var. **novangliae** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, 1923, p. 104, pl. 23, fig. 1; pl. 24, fig. 1. (Recent.)

Test ovate, biconvex, close-coiled; periphery with a sharp, limbate keel of clearer shell material; chambers eight in the last whorl, the last one drawn out to a point at the apical end; apertural face flat; sutures slightly limbate and curved; aperture produced, at the periphery of the last chamber, small, round, radiate. Length, 0.7 mm.; breadth, 0.56 mm. Rare.

**Lenticulina theta** Cole Plate 1, fig. 2

**Lenticulina theta** Cole, Bull. Am. Pal., vol. 14, no. 51, 1927, p. 14, pl. 1, fig. 17. (Eocene.)

Test ovate, biconvex, close-coiled; periphery with limbate keel, not flanged; chambers seven, gradually increasing in size, the later ones typically triangular in shape, embracing to the umbo, the last chamber drawn out to a point at the apical end; sutures flush, slightly limbate; surface smooth; wall thick; aperture small, round, radiate. Length, 0.45 mm.; diameter, 0.35 mm. Rare.

The Ecuador specimen is exactly like the type, figured by Cole from the Guayabal, Eocene of Mexico.

### Genus FLABELLINA d'Orbigny, 1839

**Flabellina budensis** Hantken Plate 1, fig. 3

**Flabellina budensis** Hantken, A magy. kir. földt. int. évkönyve, 4, 1875 (1876), p. 37, pl. 4, fig. 17; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 44, pl. 4, fig. 17. (Lower Oligocene.)

Test very flat and broad, elongate to ovate, coming to a blunt and often apiculate point at the apical end; chambers numerous, narrow, closely appressed, partially coiled in the early portion of the test, later chambers V-shaped, forming an angle towards the aperture of about twenty-five or more degrees; sutures of clear shell material, slightly depressed; surface smooth; aperture terminal. Length, 0.55 mm. to 0.66 mm.; breadth, 0.4 mm. Abundant.

### Genus FRONDICULARIA Defrance, 1824

**Frondicularia striata** d'Orbigny Plate 1, fig. 4

**Frondicularia striata** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 256, no. 3. —Parker, Jones and Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 161, pl. 10, fig. 67, from Soldani.—Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci. Nat., ser. 5, vol. 9, 1901, p. 45, pl. 3, fig. 12. (Pliocene - Recent.)

Test elongate, much compressed, gradually tapering; periphery keeled; initial end bluntly rounded; chambers numerous, narrow, V-shaped, making an acute angle towards the aperture of about sixty degrees, closely appressed; wall thicker in the early portion of the test, strongly costate longitudinally, about ten costae on one side; aperture terminal, round. Length of broken specimen, 1.1 mm.; breadth, 0.35 mm. Common.

The Ecuador specimen is almost exactly like the one figured by Fornasini from the Pliocene of Bologna.

### Genus MARGINULINA d'Orbigny, 1826

**Marginulina** sp. Plate 1 fig. 5

Test stout, curved, the initial end bulbous in a megaspheric specimen; chambers few, three in a broken specimen, inflated, decreasing in size as added; showing a slight vestigial coil; sutures distinct; surface smooth; aperture central, large, round, not definitely radiate. Length, 0.7 mm.; breadth, 0.4 mm. Rare.

The one broken specimen cannot be even generically identified with certainty.

### Genus GLANDULINA d'Orbigny, 1826

**Glandulina laevigata** (d'Orbigny) Plate 1, fig. 6

**Nodosaria** (sous-genre **Glandulina**) **laevigata** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 252, no. 1, pl. 10, figs. 1-3. (Pliocene to Recent.)

**Glandulina laevigata** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 20, pl. 1, figs. 4-5. (Miocene.)—Chapman and Parr, Jour. Linn. Soc. London, Zool., vol. 36, 1926, p. 378, pl. 17, fig. 20. (Jurassic to Recent.)

Test fusiform; chambers three to four visible, the last-formed one constituting two-thirds of the test; sutures flush, distinct; surface smooth; aperture terminal, produced, round, small, radiate. Length, 0.94 mm.; breadth, 0.6 mm. Rare.

**Glandulina comata** (Batsch) Plate 1, fig. 7

**Nautilus comatus** Batsch, Conch. Seesands, 1791, pl. 1, fig. 2 c-d. (Recent.)
**Glandulina comata** Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci. Nat. ser. 5, vol. 8, 1899-1900, pp. 93-138, text figure 29; pl. 5, fig. 29. (Recent.)

Test pyriform, apiculate; chambers few, not well marked; surface marked by about twenty-four distinct costae, which run about three-quarters of the way up the test, leaving the last quarter smooth; aperture terminal, large, round, radiate. Length, 0.65 mm.; breadth, 0.43 mm. Rare.

The Ecuador specimen is very like the specimen figured by Fornasini from the Recent of Porto Corsini, Italy.

### Genus DENTALINA d'Orbigny, 1826 (1840)

**Dentalina pauperata** d'Orbigny Plate 1, fig. 8

**Dentalina pauperata** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 46, pl. 1, figs. 57-58. (Miocene.)—Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 324, pl. 13, fig. 7. (Middle Oligocene.)—Franke, Abh. Ber. Mus. Natur Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, 1925, p. 166, pl. 5, fig. 26. (Lower Oligocene.)

Test elongate, curved, round in cross section; chambers numerous, (seven in a broken specimen), gradually enlarging, early ones closely appressed and cylindrical, last two or three somewhat bulbous; sutures distinct, slightly oblique, especially in the later portion, limbate in the earlier part of the test, of clear shell material, constricted between the last two or three chambers; surface smooth; aperture protruding, round, radiate, near the concave side of the test. Length, 1.7 mm. Rare.

Our specimens have the initial end broken off so that we cannot tell whether or not there was an apical spine, as in d'Orbigny's specimens.

### Genus NODOSARIA Lamarck, 1812

**Nodosaria acuminata** Hantken Plate 1, fig. 9

**Nodosaria acuminata** Hantken, A magy. kir. földt. int. évkönyve, 4, 1875 (1876), p. 23, pl. 2, fig. 9; pl. 13, fig. 5; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 28, pl. 2, fig. 9; pl. 13, fig. 5. (Oligocene.)—Cushman, Jour. Pal., vol. 1, no. 2, 1927, p. 155, pl. 24, fig. 9. (Lower Oligocene.)

Test elongate, slender, nearly straight, gradually tapering towards the apical end, which usually has a short apical spine; chambers somewhat inflated, eleven in a broken specimen; sutures distinct, depressed, of clear shell material; surface ornamented with six prominent, longitudinal costae which are continuous throughout the length of the test; aperture round, not produced, minutely radiate. Length, 0.84 mm. Common.

**Nodosaria vertebralis** (Batsch) Plate 1, fig. 10

**Nautilus vertebralis** Batsch, Conch. Seesands, 1791, pl. 2, fig. 6 a-b. (Recent.)

**Nodosaria vertebralis** Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 514, pl. 63, fig. 35; pl. 64, figs. 11-14.—Cushman, U. S. Geol. Surv, Prof. Pap. 133, 1923, p. 27, pl. 4, fig. 1.—Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 88, pl. 5, fig. 10. (Eocene.)

**Nodosaria obliqua** Cushman, U. S. Geol. Surv. Prof. Pap. 129 F, 1921, p. 129, pl. 30, fig. 6. (Eocene to Recent.)

Test elongate, tapering, slightly curved, with an apical spine; chambers numerous, ten in a broken specimen, slightly inflated, broader than long, the initial chamber bulbous; (megaspheric specimen); sutures limbate, of clear shell material; surface ornamented with twelve or more prominent, coarse, longitudinal costae, some of which are continuous throughout the length of the test, others are intercalated; aperture round, radiate. Length, 1.9 mm. Rare.

The Ecuador specimen is almost exactly like the one figured by Cushman from the Middle Oligocene of Mississippi.

**Nodosaria obliquestriata** (Reuss) Plate 1, fig. 11

**Dentalina obliquestriata** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 63, pl. 3, figs. 11-12. (Middle Oligocene.)

Test elongate, cylindrical, straight; chambers in broken specimens three, which are distinctly marked by deep sutures; surface smooth, except for about ten slightly oblique, longitudinal striae which cross the sutures but become obsolescent on the middle of the chambers; aperture round. Length of broken specimen, 0.75 mm. Rare.

**Nodosaria** sp. Plate 1, fig. 12

**Nodosaria** sp. Cole, Bull. Am. Pal., vol. 14, no. 51, 1927, p. 17, pl. 1, fig. 21. (Eocene.)

Test elongate, with apical spine; consisting of three inflated chambers; sutures depressed, not oblique; surface provided with about ten prominent, sharp costae, five of which arise on one chamber and fade out in the next one above, where five other, alternating costae arise and fade out in the next chamber above; aperture round, doubtfully radiate. Length, 0.72 mm. Rare.

This is probably a new species but is not named as such on account of the imperfect conditions of our specimens. The Ecuador specimen is like the one figured by Cole from the Guayabal, Eocene of Mexico.

**Nodosaria consobrina** (d'Orbigny) Plate 1, fig. 13

**Dentalina consobrina** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 46, pl. 2, figs. 1-2. (Miocene.)—Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 323, pl. 13, figs. 1-4. (Middle Oligocene.)—Neugeboren, Denkschr. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 12, pt. 2, 1856, p. 86, pl. 3, fig. 15. (Miocene.)—Cushman and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, no. 8, 1927, p. 214, pl. 13, figs. 12-13. (Eocene.)

Test elongate, slender, slightly curved, with an apical spine; chambers five in a broken specimen, increasing in size, the later ones twice as long as broad; sutures distinct, constricted, not oblique; surface smooth; aperture round, radiate. Length, 1.2 mm. Common.

This species is a generalized form which is of little value in correlation. It has been recognized from the Middle Jurassic to the Recent.

**Nodosaria emaciata** (Reuss) Plate 1, fig. 14

**Dentalina emaciata** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 63, pl. 3, fig. 9. (Middle Oligocene.)

Test elongate, slender, tapering, curved, the initial end bulbous;

chambers ten in a broken specimen, elongate, increasing in size, the later ones twice as long as broad; sutures depressed, not oblique, limbate, of clear shell material; surface smooth, transparent; aperture round, doubtfully radiate. Length, 0.9 mm. Common.

**Nodosaria arundinea** Schwager Plate 1, fig. 15

**Nodosaria arundinea** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 211, pl. 5, figs. 43-45. (Pliocene.)—Sherborn and Chapman, Jour. Roy. Micr. Soc., ser. 2, vol. 6, 1866, p. 747, pl. 14, figs. 28-29. (Lower Eocene.)—Cushman and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, no. 8, 1927, p. 215, pl. 13, fig. 14. (Eocene.)
**Nodosaria calamus** Silvestri, Atti Accad. Gioenia Sci. Nat. Catania, ser. 3, vol. 7, 1872, p. 87, pl. 10, figs. 243-251. (Pliocene.)

Test slender, very elongate, straight, subcylindrical; chambers two to three times as long as broad, probably numerous though no complete specimen was found; sutures indistinct, somewhat depressed; surface smooth; aperture round, probably radiate, indistinct in our specimens. Length, 1.1 mm. Common.

**Nodosaria pyrula** of authors Plate 1, fig. 16

**Nodosaria pyrula** Cushman (not d'Orbigny), U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 49, pl. 26, figs. 1-3; Bull. 104, pt. 4, 1923, p. 69, pl. 16, figs. 1-4. (Recent.)

Several broken specimens of one chamber each. The chambers are fusiform to pyriform, the extremities being long and narrow; surface smooth; wall finely perforate; aperture round, doubtfully radiate. Length, 0.5 mm. Common.

On account of the absence of the complete test the form cannot be certainly identified.

**Nodosaria** sp. Plate 1, fig. 17

Several broken segments of a strangulated *Nodosaria* were found but no complete ones. Each specimen shows the broken attachment to a previous chamber and a round, non-radiate aperture at the end of a long, tapering neck. The open lower side shows that it is not *Lagena*. Common.

**Nodosaria adolphina** (d'Orbigny) Plate 2, fig. 1

**Dentalina adolphina** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p.

51, pl. 2, figs. 18-20. (Miocene.)—Borneman. Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 324, pl. 13, fig. 5. (Middle Oligocene.)—Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 623, pl. 1, fig. 39. (Eocene.)—Cushman and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, no. 8, 1927, p. 213, pl. 13, figs. 8-9. (Eocene.)

Test elongate, slender, gradually enlarging; chambers subglobular, three in a broken specimen; sutures constricted, not oblique; surface smooth except for two annuli of spines on the lower third of each chamber; aperture small, round, central, doubtfully radiate. Length, 0.4 mm. Rare.

**Nodosaria lepidula** Schwager Plate 2, fig. 2

**Nodosaria lepidula** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 210, pl. 5, figs. 27-28. (Pliocene.)

Test elongate, slender; chambers three in a broken specimen, bulbous; sutures distinct, very much constricted; surface smooth except for an annulus of five to eight spines on the lower third of each chamber; aperture large, round, doubtfully radiate. Length, 0.5 mm. Rare.

This species differs from *N. adolphina* (d'Orbigny) in having only one annulus of spines whereas *N. adolphina* has two annuli of spines.

**Nodosaria annulifera** Gümbel Plate 2, fig. 3

**Nodosaria annulifera** Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 614, pl. 1, fig. 21. (Eocene.)

Test elongate, straight, gradually tapering; chambers globular, six in a broken specimen; sutures constricted, depressed; surface smooth, granular in calcified specimens; aperture small, round, slightly produced, indistinctly radiate. Length, 0.32 mm. Rare.

This species is more slender than *N. radicula* (Linné) and the chambers are closer together and less nearly spherical.

**Nodosaria holserica** Schwager Plate 2, fig. 4

**Nodosaria holserica** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 221, pl. 5, fig. 49. (Pliocene.)

Test short, consisting of two rather large, bulbous chambers; sutures constricted; surface granular in appearance due to numerous minute spines; aperture round, at the end of a long protruding neck, obscurely radiate. Length, 0.5 mm. Rare.

The Ecuador specimen is exactly like the type figure of Schwager's.

**Nodosaria conspurcata** Reuss Plate 2, fig. 5

**Nodosaria conspurcata** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 59, pl. 3, fig. 3; Sitz. k. Ak. Wiss. Wien. Math.-Naturw. Cl., vol. 48, 1863 (1864), p. 43, pl. 2, figs. 10-12; Denkschr. k. Ak. Wiss. Wein, Math.-Naturw. Cl., vol. 25, 1865, p. 130, pl. 2, figs. 19-21. (Middle Oligocene.)—Franke, Abh. Ber. Mus. Natur Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, 1925, p. 166, pl. 5, fig. 25. (Lower Oligocene.)

Test short, stout, consisting of two or more bulbous chambers; sutures constricted; surface covered with numerous short, stout spines; aperture at the end of a protruding neck, round, doubtfully radiate; broken off in our specimen. Length, 0.6 mm. Rare.

### Genus LAGENONODOSARIA Silvestri, 1900

Genotype (monotypic), **Lagenonodosaria separans** (Brady) = **Nodosaria scalaris** var. **separans** Brady, Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 511, pl. 64, figs. 16-19. (Recent, off New Zealand, 275 fathoms.)

**Lagenonodosaria** Silvestri, Atti Rend. R. Accad. Sci. Lett. Arti Zelanti, Acireale. Mem. Cl. Sci., vol. 10, 1900, p. 12; Atti Pont. Accad. Rom. Nuovi Lincei, vol. 55, 1902, p. 56, figs. 4-9; vol. 57, 1904, p. 144.

**Nodogenerina** Cushman, Contrib. Cushman Lab. Foram. Res., vol 2, 1927, p. 79; vol. 3, 1927, p. 63; Foraminifera, 1928, p. 240.

Test free, straight or slightly curved, round in section, with or without apical spine; chambers several, closely appressed throughout or closely appressed in the early portion and separated by necks in the later portion or separated by necks throughout; sutures distinct, at right angles to axis of test, except in the early portion of the microspheric form where they may be slightly oblique; walls calcareous, hyaline, finely perforate, smooth, spinose or costate; aperture single, round, small, at the end of a long neck, with or without phialine lip, sometimes rudimentarily radiate. Length up to 8 mm. or more.—Shallow to deep, usually warm water.—Jurassic (?), Cretaceous to Recent, common.

Many species of *Nodosaria* of authors belong to *Lagenonodosaria,* which differs from *Nodosaria* in the long neck and phialine aperture which is imperfectly or not at all radiate.

**Lagenonodosaria monilis** (Silvestri) Plate 3, fig. 1

**Nodosaria monilis** Silvestri, Atti Accad. Gioenia Sci. Nat., ser. 3, vol. 7, 1872, p. 71, pl. 8, figs. 173-183. (Pliocene.)

**Nodosaria monile** Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci.

Nat., ser. 5, vol. 8, 1900, p. 115, pl. 7, fig. 28. (Recent.)

Test elongate, straight, gradually enlarging; chambers bulbous, two in broken specimens; sutures very much constricted giving a strangulated appearance; surface covered with two to four annuli of short, thick spines which point toward the apical end, those of one annulus alternating with those in preceeding and succeeding annuli; aperture terminal, central, round, not radiate. Length of broken specimen, 0.5 mm. Rare.

Silvestri's species appears to be a *Lagenonodosaria* rather than a *Nodosaria* on account of the aperture with phialine lip, not radiate as in *Nodosaria*.

### Genus LAGENA Walker and Boys, 1784

**Lagena asperoides** n. sp. Plate 2, fig. 6

**Lagena aspera** Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 16, pl. 16, fig. 1. (Recent.)

Test spherical, except for a long, tapering neck; surface covered with numerous short, thick spines; aperture round, at the end of the neck, with phialine lip. Length, 0.57 mm; breadth, 0.36 mm. Common.

*Holotype.* Columbia University Paleo. Coll. No. 19952.

This species differs from *L. hystrix* Reuss in the conical, rather than cylindrical shape of the spines, and from *L. aspera* Reuss in the spherical shape and long, large neck. It seems to be exactly like the Recent *L. aspera* of Cushman (not Reuss), which he states has been found in the Eocene, Oligocene, Miocene, Pleistocene and Recent.

**Lagena semistriata** Williamson Plate 2, fig. 7

**Lagena vulgaris** var. **semistriata** Williamson, Rec. Foram. Great Britain, 1858, p. 6, pl. 1, fig. 9. (Recent.)

Test ovate, globular, apiculate, with about twenty-two, thick, longitudinal costae which commence a short distance from the short, apiculate spine and disappear towards the apertural end, leaving the last two-fifths of the test smooth; aperture round, at the end of a long neck, which is broken off in our specimen. Length, 0.42 mm; breadth, 0.37 mm. Rare.

**Lagena strumosa** Reuss Plate 2, fig. 8

**Lagena strumosa** Reuss, Zeitschr. deutsch. geol. Gesell., 1858, p. 434, no fig.; Sitz. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 46, pt. 1, 1862 (1863), p. 328, pl. 4, fig. 49. (Oligocene-Miocene.)

Test bulbous, with short spines and long apertural neck; surface ornamented with about twenty-five fine, longitudinal costae; wall very finely perforate; aperture round, with phialine lip; the neck is broken off in our specimens. Length, 0.3 mm; breadth, 0.23 mm. Common.

**Lagena sulcata apiculata** Cushman Plate 2, fig. 9

**Lagena sulcata** var. **apiculata** Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 23, pl. 9, figs. 3-4. (Recent.)

Test bulbous, with sixteen distinct costae which extend from the apical end to a ring at the base of the neck; apical end probably drawn out into a spine which is broken off in our specimen; aperture round, at the end of a long, tapering neck which has an annulus near its base, probably representing the beginning of a second chamber. Length, 0.36 mm; breadth, 0.24 mm. Rare.

The annulus at the neck of this form, and the apertural neck show that it was derived from *Lagenonodosaria,* and the annulus is a vestage of an undeveloped chamber.

### Genus ROBULUS Montfort, 1808

**Robulus calcar** (Linné) Plate 2, fig. 10

**Nautilus calcar** Linné, Syst. Nat., ed. 10, 1758, p. 709; ed. 13 (Gmelin's), 1788, p. 3370, named from figures by Plancus, De Conchis Minus Notis, 1739, p. 1, pl. 12, figs. 3-4, or Gaultieri, Test. Conch. Index, 1742, pl. 19, fig. c. (Recent.)
**Cristellaria calcar** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, 1923, p. 115, pl. 31, fig. 4. (Recent.)

Test discoidal, biconvex, close-coiled, biumbonate; periphery with narrow keel and three or four short spines; chambers few, about four to six, triangular; sutures indistinct, curved; surface smooth; aperture an elongate slit on the face of the last chamber, near the periphery, radiate on the outside. Diameter, 0.44 mm. Abundant.

The figure of Plancus has no spines on the periphery, whereas that of Gaultieri, which our specimens closely resemble, has short spines.

**Robulus cf. deformis** (Reuss) Plate 2, fig. 11

**Robulina deformis** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 70, pl. 4, fig. 30. (Middle Oligocene.)

Test bulbous, trihedral, consisting of two chambers commencing to coil, with carina on the outside edge and two ridges on the inner side of the chambers; proloculum very large; surface smooth; aperture a vertical slit at the apex of the last chamber, near the periphery, radiate outside. Diameter, 0.38 mm. Common.

Our specimens are very young megaspheric ones and cannot therefore be identified exactly.

**Robulus deformis** (Reuss) var. Plate 2, fig. 12

This specimen differs from the others of the species in having two costae on one side of the proloculum. Diameter, 0.38 mm. Rare.

**Robulus duracina** (Stache) Plate 2, fig. 13

**Cristellaria duracina** Stache, Novara-Exped., vol. 1, pt. 2, 1864, p. 237, pl. 23, fig. 16 a-b. (Middle Tertiary.)

Test discoidal, strongly biconvex; periphery angled; chambers twelve to fifteen in the last whorl; sutures slightly curved, limbate, tangential to the earlier whorl; aperture round, small, terminal, slightly produced, finely radiate, with secondary aperture near the principal one, on the outer face of the septum, oval with raised rim. Diameter, 0.6 mm. Rare.

**Robulus taettowata** (Stache) Plate 2, fig. 14

**Robulina taettowata** Stache, Novara-Exped., vol. 1, pt. 2, 1864, p. 252, pl. 23, fig. 32 a-b. (Middle Tertiary.)

Test lenticluar, umbonate, with narrow, rounded carina which extends down the sides of the last septal face; surface smooth; chamers about six to a whorl, which embrace to the umbo; sutures slightly curved, broadly limbate, slightly raised in the adult; aperture an elongate slit on the upper edge of the septal face, with coarse radial ridges on the outside, which show near the periphery on the last three or four chambers. Diameter of adult, 1.1 mm; thickness, 0.63 mm. Abundant.

### Genus FISSURINA Reuss, 1850

**Fissurina carinata** Reuss Plate 2, fig. 15

**Fissurina carinata** Reuss, Sitz. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 46, pt. 1, 1862 (1863), p. 338, pl. 6, fig. 83; pl. 7, fig. 86. (Oligocene-Miocene.)—Terquem, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 31, pl. 1, (19), fig. 23 a-b. (Eocene.)

Test small, compressed, ovate in side view, elliptical in edge view; surface smooth with an angled peripheral keel; wall finely perforate; aperture a narrow, elongate slit, parallel to the flattened sides of the test. Length, 0.2 to 0.25 mm.; diameter, 0.2 mm. Rare.

One of our specimens is like that which Reuss had and the other, which is a broader specimen, is exactly like that which Terquem had in his material from the Eocene near Paris.

**Fissurina globosa** Bornemann Plate 2, fig. 16

**Fissurina globosa** Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 317, pl. 12, fig. 4. (Middle Oligocene.)
**Lagena globosa** Jones, Parker and Brady, Pal. Soc. London. pt. 1, 1866, pl. 1, fig. 32. (Pliocene.)

Test bulbous, slightly compressed, pyriform in side view, broadly elliptical in edge view, with a short apical spine; surface smooth except for a sharp, narrow keel on the first half of the test; wall hyaline, finely perforate; aperture a small, elongate slit at the end of a protuberance which is marked at its base by a line of clear shell material, Length, 0.3 mm.; diameter, 0.25 mm. Rare.

The Ecuador specimen is exactly like Borneman's type figure from the Middle Oligocene of Hermsdorf.

**Fissurina orbignyana caribaea** (Cushman) Plate 2, fig. 17

**Lagena orbignyana** var. **caribaea** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, 1923, p. 41, pl. 7, figs. 6-9. (Recent.)

Test slightly compressed, ovate in side view, pyriform in edge view, with three keels of clear shell material; surface smooth except for the keels, the middle one of which broadens and includes the aperture; the two lateral keels are nearly circular;

wall hyaline, finely perforate; aperture round, at the pointed end of the test, probably entosolenian. Length, 0.5 mm.; breadth, 0.35 mm. Common.

This species differs from *Lagena orbignyana* (Seguenza) in being much thicker, especially at the aboral end.

**Fissurina staphyllearia** Schwager Plate 2, fig. 18

**Fissurina staphyllearia** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 209, pl. 5, fig. 24. (Pliocene.)

Test bulbous, very slightly compressed; wall hyaline, finely perforate; surface smooth except for a few short, eccentrically placed, apical spines; aperture an elongate slit, slightly produced. Length, 0.35 mm.; diameter, 0.3 mm. Common.

It is possible that a section of a specimen of this species would show it to be an *Ellipsolagena.*

**Fissurina** sp. Plate 2, fig. 19

**Lagena marginata** Cushman (not **Lagena marginata** Walker and Boys), U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 37, pl. 22, figs. 1-7. (Recent.)

Test compressed, subcircular in side view; eliptical in edge view, with broad keel; surface smooth; wall hyaline, finely perforate; aperture fissurine, broken in our specimen. Diameter, 0.45 mm. Rare.

### Genus LINGULINA d'Orbigny, 1826

**Lingulina** sp. Plate 3, fig. 2

Test minute, flattened, regularly tapering from the rounded initial end; edge broadly rounded; chambers comparatively few, about nine; sutures distinct, depressed; surface smooth; wall conspicuously perforate; aperture terminal, elliptical. Length, 0.23 mm.; breadth, 0.1 mm. Rare.

We have a single specimen of this form which is different from anything described, but more material is needed in order to designate it as a new species.

## Family POLYMORPHINIDAE d'Orbigny, 1846

### Genus GLOBULINA d'Orbigny, 1826

Genotype (first species, designated by Cushman, 1927) **Polymorphina (Globulina) gibba** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266; Model no. 63, 1826. (Recent, shore at Rochelle.)—Parker, Jones and Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 52.

**Globulina** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 225.—Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 4, 1927, p. 188.

**Raphanulina** Zborzewski, Nouv. Mém. Soc. Imp. Nat. Moscou, vol. 3, 1834, p. 311, pl. 28, fig. 1 a.

**Aulostomella** Alth, Haidinger's Nat. Abh., vol. 3, pt. 2, 1850, p. 264.

**Glandulopolymorphina** Silvestri, Boll. Accad. Gioenia Sci. Nat. in Catania, n. ser., fasc. 69, 1901, p. 17.

**Misilus** Montfort, Conch. Syst., vol. 1, 1808, p. 294, Not definitely recognizable.

**Polymorphina** (part) of authors.

Test free, globular, oval or round in longitudinal and cross sections; chambers few, closely appressed, arranged in a high spire, three to a whorl, usually three chambers visible externally; sutures flush with the surface; wall calcareous, hyaline, finely perforate, smooth, costate or spinose; aperture terminal, slightly produced, round, radiate, frequently fistulose due to degeneration of the last chamber. Length, up to 2 mm.—Mostly in shallow water, but down to over 1500 fathoms.—Jurassic to Recent, more common in Tertiary and Recent.

**Globulina ovata** d'Orbigny Plate 3, fig. 10

**Globulina ovata** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, no. 22.—Fornasini, Boll. Soc. Geol. Italiana, vol. 19, 1900, p. 147, text figure 5. (Recent and Miocene.)

Test broadly oval in side view and cross section; chambers greatly embracing, three visible in megaspheric specimens; sutures distinct, flush; surface smooth; aperture terminal, round, radiate. Length of megaspheric specimen, 0.5 mm.; breadth, 0.27 mm. Rare.

*Polymorphina ovata* d'Orbigny, figured in his Vienna Basin Report, is a different form.

### Family ROTALIIDAE Reuss, 1861

### Genus GLOBOROTALIA Cushman, 1927

**Globorotalia canariensis** (d'Orbigny) Plate 3, fig. 11

**Rotalina canariensis** d'Orbigny, in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foram., 1839, p. 130, pl. 1, figs. 34-36. (Recent.)

**Pulvinulina canariensis** Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 692, pl. 103, figs. 8-10. (Recent.)

Test small, unequally biconvex, ventral side more so, with small umbilicus; peripheral margin acute; periphery lobulate; chambers five in the last whorl; sutures on the dorsal side of clear shell material, and much curved, nearly flush with the surface, depressed on the ventral side, and slightly curved; wall very finely perforate; surface smooth, except the early part of the last whorl which is granulate on the ventral side; aperture an elongate opening extending from the umbilicus part way to the periphery. Length, 0.33 mm.; breadth, 0.27 mm. Abundant.

### Genus ROTALIA Lamarck, 1804

**Rotalia advena** Cushman Plate 3, fig. 12

**Rotalia advena** Cushman, U. S. Geol. Surv. Prof. Pap. 133, 1923, p. 46, pl. 7, figs. 4-6. (Oligocene.)

Test unequally biconvex, biumbonate, the dorsal side slightly convex, the umbonal region more elevated, the ventral side deep; peripheral margin angled and limbate; chambers five in the last whorl; sutures on the dorsal side limbate, flush, very little curved, tangential to the previous whorl, scarcely visible on the spire, on the ventral side slightly limbate, very little curved or depressed, radial to the umbo; wall finely perforate; surface smooth, glistening; aperture a narrow slit on the inner margin of the last chamber nearer the periphery than the umbo. Diameter, up to 0.35 mm. Common.

The Ecuador specimens have a sharper peripheral angle than the Alabama types of the species.

**Rotalia ecuadorensis** n. sp. Plate 3, fig. 13

Test discoidal, unequally biconvex, the ventral side the deeper, umbonate on both sides, the umbo on the ventral (apertural) side being the more prominent; periphery slightly lobulate; peripheral margin angled; chambers five to six in the last whorl; sutures on the dorsal side flush, of clear shell material, curved and slightly oblique, sutures on the ventral side flush, of clear shell material, slightly curved and nearly radial in the outer half, strongly curved in the inner half, in the umbo; aperture a narrow slit near the periphery on the inner margin of the last chamber, with lip. Diameter, up to 0.36 mm. Common.

*Holotype.* Columbia University Paleo. Coll. No. 19953.

This species resembles *R. umbonata* but differs in the curved sutures in the ventral umbo, a constant character of the species.

**Rotalia umbonata** (Reuss) Plate 4, fig. 1

**Rotalina umbonata** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 75, pl. 5, fig. 35. (Middle Oligocene.)

**Pulvulina umbonata** Hantken, A magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 67, pl. 9, fig. 8; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 77, pl. 9, fig. 8. (Lower Oligocene).

**Truncatulina tenera** Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 665, pl. 95, fig. 11 a-c. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 37, pl. 16, fig. 2; pl. 23, fig. 6. (Recent.)—Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 146, pl. 9, fig. 5. (Eocene.)

**Eponides umbonata** Cole, Bull. Am. Pal., vol. 14, 1928, p. 15, pl. 2, fig. 6. (Upper Eocene.)

Test nearly equally biconvex, ventral side more so and without definite umbilicus; dorsal side convex in the middle making an umbo in which the spire is obscured; the outer whorl being flat and lower than the central part; periphery lobulate, peripheral margin acute; chambers five to six in the last whorl; sutures nearly straight and radial on both sides, flush and limbate dorsally, slightly depressed ventrally and curved towards the umbo in gerontic specimens; wall very finely perforate; surface smooth and white; aperture an elongate slit near the periphery on the inner margin of the last chamber, with slight lip. Diameter, up to 0.8 mm. Abundant.

Some gerontic specimens are more ventricose than the normal form, and the last whorl is more involute on the ventral side, making a shoulder between it and the next to the last whorl.

This form is not coarsely perforate and the aperture does not extend over into the dorsal side, hence it is not a *Cibicides* (*Truncatulina* of authors).

### Genus GYROIDINA d'Orbigny, 1826

**Gyroidina laevis** d'Orbigny Plate 4, fig. 2

**Gyroidina laevis** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278, no. 3. (Recent, Pliocene and Miocene.)—Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci. Nat., ser. 5, vol. 7, 1898, p. 260, fig. 7.

Test unequally biconvex, the dorsal side low, ventral side deep and umbilicate; periphery not lobulate except slightly in the last few chambers; peripheral margin sharply curved; chambers about eleven in the last whorl; sutures on the dorsal side distinct, of clear shell material, slightly curved and nearly radial; sutures between the whorls not depressed; sutures on the ventral side slightly depressed and curved; surface smooth; aperture an elongate slit on the inner margin of the last septal face extending from near the umbilicus to near the periphery. Diameter, 0.3 mm. Common.

This species is less ventricose than the more typical species of the genus *Gyroidina.*

**Gyroidina nitidula** (Schwager) Plate 4, fig. 3

**Rotalia nitidula** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 263, pl. 7, fig. 110. (Pliocene.)

Test plano-convex; dorsal side depressed, with a deep groove between the last two whorls and umbonate center in which the spire is scarsely visible; ventral side strongly ventricose, with deep umbilicus; chambers about nine in the last whorl; sutures slightly depressed and curved, deeply depressed near the umbilicus; wall very finely perforate; surface smooth; aperture an elongate slit between the periphery and the umbilicus on the inner margin of the chamber. Diameter, up to 0.9 mm. Common.

This species differs from *Gyroidina soldanii* d'Orbigny, in the larger size of the test and the deeper depression between the last two whorls, and the more closely appressed whorls.

**Gyroidina soldanii** d'Orbigny Plate 4, fig. 4

**Gyroidina soldanii** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278, no. 5; Modèles, no. 36.

**Rotalina soldanii** d'Orbigny, Foram. Foss. Bass. Tert. Vienne. 1846, p. 155, pl. 8, figs. 10-12. (Miocene.)

**Rotalia soldanii** Hantken, A magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 69, pl. 9, fig. 7; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 80, pl. 9, fig. 7. (Upper Eocene-Lower Oligocene.)—Andrae, Abh. geol. Specialkarte Elsass-Loth., vol. 2, pt. 3, 1884, p. 155, pl. 9, fig. 3. (Middle Oligocene.)—Brady, Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 706, pl. 107, figs. 6-7. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 71, pl. 29, fig. 1. (Recent.)

Test plano-convex; dorsal side nearly flat; ventral side strongly convex with deep umbilicus; chambers nine to eleven in the last whorl; sutures distinct, slightly depressed; wall very finely perforate; surface smooth; aperture an elongate slit between the periphery and the umbilicus on the inner margin of the chamber. Diameter, up to 0.5 mm. Abundant.

### Genus ANOMALINA d'Orbigny, 1826

Genotype (first species, designated by Cushman, 1915) **Anomalina punctulata** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 282, pl. 15, figs. 1-3. (Recent, Island of Mauritius.)—d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 169.

**Discorbina** (part) Brady, Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 648 ff., **D. parisensis, D. bertheloti, D. rarescens.**

**Truncatulina** (part) Cushman, U. S. Geol. Surv. Bull. 676, 1918, p. 63; **T. americana** Cushman; U. S. Geol. Surv. Prof. Pap. 129 E. 1922, p. 97, pl. 20, figs. 7-8.

**Anomalina** (part) Cushman, U. S. Geol. Surv. Prof. Pap. 129 E, 1922, p. 98.

**Anomalina,** most species of authors, equals **Planulina.**

Test free, plano-convex, convex and entirely embracing on the side oposite the aperture, depressed and partially embracing on the apertural side; whorls few; chambers numerous, closely appressed or inflated, rapidly enlarging; wall hyaline, conspicuously perforate, medium to coarse, but not as coarse as in *Cibicides;* surface smooth or punctulate; aperture a slit at the base of the septum extending from the umbilicus onto the periphery. Diameter, up to 0.75 mm.—Mostly in shallow water, but down to 2160 fathoms.—Cretaceous to Recent.

*Anomalina* differs from *Planulina* in being involute on one side; from *Discorbis* and *Cibicides* in being involute on the side opposite the aperture and somewhat involute on the spiral side. d'Orbigny's model of *Anomalina elegans* shows the characters of the genus better than does his figure of *A. punctulata.*

**Anomalina mantaensis** n. sp. Plate 4, fig. 5

**Truncatulina americana** Cushman, U. S. Nat. Mus. Bull. 103, 1919, p. 68, pl. 23, fig. 2 a-c.—U. S. Geol. Surv. Prof. Pap. 129 E, 1922, p. 97, pl.

20, figs. 7-8. (Upper Oligocene), (Not Cushman, U. S. Geol. Surv. Bull. 676, 1918, p. 63.)

**Discorbis** sp. Cushman, U. S. Geol. Surv. Prof. Pap. 133, 1923, p. 39, pl. 6, figs. 5-6. (Lower Oligocene.)

Test plano-convex, dorsal side flat, ventral side convex, and entirely involute, umbilicate, with a clear boss in the umbilicus; the last whorl tends to embrace the spire on the dorsal side and is raised above the preceeding whorl, leaving a cleft in which the apertures open; periphery sharply angled, limbate; chambers about ten in the last whorl; sutures curved and limbate on both sides, of clear shell material, raised on the dorsal side, depressed on the ventral side; wall hyaline, conspicuously perforate, more coarsely than in *Rotalia;* aperture at the end of the chamber toward the spire, on the dorsal side of the test, covered in some cases with a small valvular flap, the apertures of about four chambers visible. Length, up to 0.48 mm.; breadth, up to 0.38 mm. Abundant.

*Holotype.* Columbia University Paleo. Coll. No. 19954.

### Genus CIBICIDES Montfort, 1808

**Cibicides alleni** (Plummer) Plate 4, fig. 6

**Truncatulina alleni** Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 144, pl. 10, fig. 4 a-c. (Eocene.)

Test discoidal, entirely involute on the ventral side, partially involute on the dorsal side, the ventral side more convex than the dorsal; periphery scarcely at all lobulate except the outside of the last two or three chambers, and bordered by a blunt keel of clear shell material; peripheral margin bluntly angled; chambers ten to twelve in the last whorl; sutures slightly curved, limbate and raised on the dorsal side, the sutures between the whorls raised into a spiral line, and fused with thickening covering the spire; sutures on the ventral side slightly curved, more so toward the outer ends, limbate, raised in the earlier part of the last whorl, depressed in the later part; center of the ventral side with a raised umbo of clear shell material; wall coarsely perforate; aperture on the periphery, with outer lip, and extending along the suture between the last two whorls on the dorsal side for a distance of three or four chambers. Diameter, up to 1.15 mm. Rare.

**Cibicides dohertyi** n. sp. Plate 4, fig. 7

Test biconvex, depressed, the last whorl not embracing to the umbilicus on the ventral side, dorsal side nearly flat, ventral side slightly convex, with spiral depression under the periphery, and umbilicus filled with clear shell material but not raised into an umbo; peripheral margin sharp, keeled; periphery slightly lobulate; chambers eight to ten in the last whorl, narrow, slightly inflated on both sides of the test; sutures depressed, limbate, especially on the dorsal side, and much curved on both sides of the test; wall very coarsely perforate; surface smooth, with little secondary thickening; aperture narrow, with raised lip, at the base of the septal face on the inner periphery and continuing for half the length of a chamber on the dorsal side. Diameter, up to 1.3 mm. Abundant.

*Holotype.* Columbia University Paleo. Coll. No. 19955.

This species differs from *C. wuellerstorfi* in the thicker test, in the fewer, longer and less curved chambers, lack of embracing of the last whorl on the dorsal and ventral sides, and less pronounced dorsal portion of the aperture. It differs from *C. sandiegensis* Cushman and Hanna (Trans. San Diego Soc. Nat. Hist., vol. 4, 1927, p. 55, pl. 6, figs. 1 - 2) in the limbate sutures. It is very near to a *Planulina.*

This species is named for Mr. Henry L. Doherty, who has done much to encourage the study and application of micropaleontology.

**Cibicides haidingerii** (d'Orbigny) Plate 4, fig. 8

**Rotalina haidingerii** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 154, pl. 8, figs. 7-9. (Miocene.)

**Truncatulina haidingerii** Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 663, pl. 95, fig. 7 a-c. (Recent.)

Test unequally biconvex, ventral side more convex than the dorsal and slightly umbilicate; periphery slightly lobulate; peripheral margin sharply rounded; chambers five to seven in the last whorl; sutures distinct, slightly curved on both sides of the test, limbate, and flush with the surface on the dorsal side and making an angle of sixty degrees with the periphery, radial and slightly depressed on the ventral side; wall thin, coarsely perforate; aperture a narrow slip at the base of the last chamber, on the periphery and extending for a distance of about one chamber on the dorsal side along the suture line. Diameter, up to .37 mm. Abundant.

**Cibicides nucleata** (Seguenza) Plate 4, fig. 9

**Truncatulina nucleata** Seguenza, Atti R. Accad. Lincei, ser. 3, Mem. Cl. Sci. Fis., Math., Nat., vol. 6, 1880, p. 64, pl. 7, fig. 8. (Lower Miocene.)

Test unequally biconvex; dorsal side slightly convex with large umbo of clear shell material which is separated from the later part of the last whorl by a deep groove; ventral side strongly convex, with large umbo; periphery broadly rounded; chambers twelve to fifteen in the last whorl, narrow; sutures broadly limbate, often indistinct, curved on both sides of the test; wall very coarsely perforate on both sides, with a pellicle of thickening tissue in adult specimens which obscures the surface features; aperture a curved opening on the periphery at the base of the last chamber extending on the dorsal side along the suture line for a distance of three to six chambers. Diameter, up to 1.1 mm. Abundant.

The conspicuous umbo is the most characteristic feature of this species.

**Cibicides ungeriana** (d'Orbigny) Plate 4, fig. 10

**Rotalina ungeriana** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 157, pl. 8, figs. 16-18. (Miocene.)

**Truncatulina ungeriana** Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 664, pl. 94, fig. 9. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 36, pl. 17, fig. 2. (Recent.)

Test unequally biconvex, ventral side more so but depressed under the periphery and slightly umbilicate; periphery with sharp, narrow carina; chambers ten to twelve in the last whorl; sutures distinct, limbate on the dorsal side and depressed on the ventral side, slightly curved; wall very coarsely perforate, with thickening over the spire on the dorsal side which reduces the number of mural pores and enlarges those remaining, less coarse on the ventral side; aperture narrow at the base of the last chamber on the periphery, with raised lip, and extending along the suture line on the dorsal side for a distance of two or three chambers. Diameter, up to 1.15 mm. Abundant.

The Ecuador specimens differ from the type figure of *C. ungeriana* in having limbate sutures and are thicker dorsoventrally.

**Cibicides wuellerstorfi** (Schwager) Plate 4, fig. 11

**Anomalina wuellerstorfi** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p.258, pl. 7, figs. 105 and 107. (Pliocene.)

**Truncatulina wuellerstorfi** Brady Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 662, pl. 93, figs. 8-9. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 34, pl. 12, fig. 3. (Recent)

Test plano-convex, compressed; dorsal side flat or sometimes slightly concave, the last part of the whorl overlapping the earlier part, with thickening on the sutures and between the pores in gerontic specimens; ventral side convex, umbonate, with coarse granulation by secondary tissue especially in the early part of the last whorl; peripheral margin usually acute, often with blunt keel; chambers nine to twelve in the last whorl, increasing in size as added, narrow, much curved; sutures distinct, limbate, curved, especially in the later part of the test; wall very coarsely perforate on both sides; aperture a narrow curved slit on the periphery at the base of the last chamber, extending on the dorsal side along the suture between the last two whorls for a distance of two or three chambers. Diameter, up to 0.9 mm. Abundant.

This species is abundant in the late Tertiary and Recent, but is of rare occurrence in the Lower Tertiary.

### Genus PLANULINA d'Orbigny, 1826

**Planulina affinis** (Hantken) Plate 4, fig. 12

**Pulvulina affinis** Hantken, A magy. kir. földt, int. évkönyve, vol. 4, 1875 (1876), p. 68, pl. 10, fig. 6; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 78, pl. 10, fig. 6. (Lower Oligocene.)

**Anomalina affinis** Cushman and Applin, Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 180, pl. 9, figs. 1-2. (Eocene.)

Test involute, nearly bilaterally symmetrical, the ventral side the deeper, ovate in side view, elliptical in face view; biumbilicate, the dorsal umbilicus generally the larger; periphery broadly angled; chambers eleven to fourteen in the last whorl; sutures of clear shell material, very little depressed, more so in the later part of the last whorl; wall coarsely perforate, but not so coarse as in *Cibicides;* surface smooth; aperture a narrow elongate slit on the inner margin of the last septal face, extending on both sides of the periphery, more on the dorsal side, with slight lip. Diameter, 0.23-0.42 mm. Abundant.

## Family CHILOSTOMELLIDAE Brady, 1884

### Genus SPHAEROIDINA d'Orbigny, 1826

**Sphaeroidina bulloides** d'Orbigny var. **chilostomata** n. var. Plate 5, fig. 1

Test subspherical in outline; chambers globular, rapidly increasing in size, four in the last whorl, the last about as large as all the others; sutures narrow, depressed; wall finely perforate; surface smooth; aperture a curved slit surrounded by a raised lip, situated at the base of the last spetal face just above the suture. Diameter, up to 0.43 mm. Abundant.

*Holotype.* Columbia University Paleo. Coll. No. 19956.

The aperture of this variety is shorter, much less curved and lacks the large tooth of *S. bulloides* d'Orbigny. The form is less nearly spherical than that of *S. austriaca* d'Orbigny and the aperture is more elongate. The aperture is similar to that of most of the genera of the *Pleurostomellidae.*

### Family VERNEUILINIDAE Cushman, 1927

### Genus VERNEUILINA d'Orbigny, 1840

**Verneuilina cyclostomata** n. sp. Plate 5, fig. 2

Test subconical, apical end bluntly rounded, apertural end broadly rounded; chambers three to four to a whorl, the early ones small, the later ones rapidly enlarging, the last whorl composing half the test; sutures indistinct, slightly depressed; wall finely arenaceous; surface fairly smooth; aperture in a depression at the base of the last chamber, round, with raised rim. Length, up to 0.87 mm. Abundant.

*Holotype.* Columbia University Paleo. Coll. No. 19957.

This species resembles *Verneuilina siphonella* (Reuss) in many respects, but it has fewer chambers in a whorl, and the septal face is concave rather than convex.

### Genus GUADRYINA d'Orbigny, 1839

**Gaudryina globulifera** Reuss Plate 5, figs. 3, 4

**Gaudryina globulifera** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 4, 1852, p. 18, fig. a-b. (Oligocene.)

**Gaudryina chilostoma** var. **globulifera** Andreae, Abh. geol. Specialkarte Elsass-Lothr., vol. 2, pt. 3, 1884, p. 200, pl. 7, figs. 8-9. (Oligocene.)

Test elongate, triangular in side view, rapidly enlarging, about two-thirds as broad as long, triserial portion composing about one-half of the test; chambers inflated except for the early triserial ones; sutures distinct, depressed; wall very finely arenaceous; surface smooth, white; aperture a narrow slit at the base of the inner margin of the last chamber, with slight lip. Length, 0.5 mm.; breadth, 0.35 mm. Abundant.

### Genus CLAVULINA d'Orbigny, 1826

**Clavulina curta** n. sp. Plate 5, fig. 5

**Clavulina parisiensis** Flint (not d'Orbigny), Rep. U. S. Nat. Mus. for 1897 (1899), p. 289, pl. 35, fig. 2. (Recent.)

Test elongate, short, robust, slightly curved, apertural end inflated, triserial portion subpyramidal, later portion cylindrical and of smaller diameter than the triserial portion; chambers three to six in the uniserial portion, slightly inflated, shorter than broad, irregular in length; sutures slightly depressed, very obscure in the triserial portion; wall coarsely arenaceous with much calcareous cement, white; surface rough; aperture terminal, central, round, with narrow rim and small tooth. Length, 1.37 mm. Common.

*Holotype.* Columbia University Paleo. Coll. No. 19958.

This species differs from *C. parisiensis* d'Orbigny, in the shorter and less regular form, more inflated chambers, and particularly in the inflated apertural end.

**Clavulina pallida** Cushman Plate 5, figs. 6, 7

**Clavulina communis** var. **pallida** Cushman, Bull. Scripps Inst. Ocean., tech. ser., vol. 1, 1927, p. 138, pl. 2, fig. 1. (Recent.)

Test elongate, nearly straight, triserial portion conical, uniserial portion subcylindrical, gradually enlarging, less in diameter than the triserial portion; apertural end truncate; chambers in the triserial portion about nine, later portion consisting of uniform, cylindrical chambers which are about half as high as wide; sutures well marked in some specimens, obscure in some, especially in the triserial portion; wall finely arenaceous, white; surface smooth; aperture central, round or oval, at the end of a short neck, which is situated in a depression. Length, up to 1.5 mm.; breadth, 0.6 mm. Common.

This species closely resembles *Clavulina clavata* Cushman, from the Upper Cretaceous of Mexico (Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 586, pl. 17, fig. 4), but the chambers are shorter. It is like *C. parisiensis* d'Orbigny except that the triserial portion is not triangular and the walls are finer grained. It differs from *C. communis* d'Orbigny in the relatively shorter chambers and the truncate apertural end.

## Family TEXTULARIIDAE d'Orbigny, 1846

### Genus TEXTULARIA Defrance, 1824

**Textularia flabelliformis** Gümbel Plate 5, fig. 8

**Textularia flabelliformis** Gümbel, Abh. k. bay. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 647, pl. 2, fig. 83 a-b. (Eocene.)

Test cuneiform, flattened, more so in the broadly rounded early portion; edges sharp; chambers seven to ten pairs, very much broader than long; sutures elevated, curved, making a median ridge where the two series of chambers join; wall coarsely arenaceous; aperture an elongate slit at right angles to the plane of flattening, situated in a reentrant at the base of the septal face, and about one-third as long as the width of the septal face. Length, up to 1 mm.; breadth, up to 0.9 mm.; thickness, up to 0.6 mm. Abundant.

This species is like the young of *Vulvulina,* but in the many specimens we have, none of the chambers are uniserial and the aperture is not like that of *Vulvulina.* It is probably the form from which *Vulvulina* was derived.

## Family HETEROHELICIDAE Cushman, 1927

### Genus BOLIVINA d'Orbigny, 1839

**Bolivina applinae** Plummer Plate 5, fig. 9

**Bolivina applini** Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 69, pl. 4, fig. 1. (Eocene.)

Test elongate, slightly flattened, obtusely pointed, sides nearly parallel, edges rounded; early portion with fine longitudinal costae, later portion smooth except for crenulations along the suture lines; chambers eight or nine on a side; aperture on elongate slit at the base of the last chamber. Length, 0.36 mm.; breadth, 0.14 mm. Rare.

This species resembles *B. nobilis* Hantken and *B. advena striatella* Cushman (Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 2, 1925, p. 30, pl. 5, fig. 3 a-b) but differs in being less compressed and in having crenulations along the suture lines between the later chambers. *B. advena striatella* Cushman has many more chambers than this species.

**Bolivina pisciformis** n. sp. Plate 5, fig. 10

Test elongate, flattened, with a sharp, narrow, serrate keel of clear shell material, initial end angled and often with an apical spine; chambers eight to twelve on a side, about twice as broad as high, meeting at an angle of about 99°; sutures distinct, of clear shell material; wall thin, very finely perforate; surface smooth except for the keel which has numerous short, sharp spines at the end of each chamber; aperture an elongate slit. Length, up to 0.65 mm.; breadth, up to 0.25 mm. Abundant.

*Holotype.* Columbia University Paleo. Coll. No. 19959.

This species resembles *B. alazanensis* Cushman (Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1926, p. 82, pl. 12, fig. 1) but differs in having narrower chambers which meet at a smaller angle (just a little more than 90°). It differs from *B. alata* (Seguenza) in having narrower chambers and being broader at the top.

### Genus PLECTOFRONDICULARIA Liebus, 1902

**Plectofrondicularia californica** Cushman and Stewart Plate 5, fig. 11

**Plectofrondicularia californica** Cushman and Stewart, Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 2, 1926, p. 39, pl. 6, figs. 9-11. (Lower Pliocene.)

Test very elongate, flattened, straight or curved at the apical end, with sides nearly parallel and flat or slightly concave, with three sharp costae on each edge, and a short costa on each side of the apical end; apical end bluntly rounded or bluntly pointed in microspheric specimens; chambers biserial in the early portion, consisting of from four to seven pairs of chambers, uniserial in the later portion and gradually increasing in height; sutures distinct, broad, very slightly depressed, of clear shell material, curved towards the apertural end; wall hyaline, very finely perforate; surface smooth, except for the costae; aperture terminal, central, oval, not definitely radiate, but with inwardly pointing teeth in adult specimens. Length of incomplete specimens, 1 mm.; breadth, 0.25 mm. Abundant.

The Ecuador specimens differ from the California specimens only in having a longer biserial stage and a longer central costa.

**Plectofrondicularia miocenica** Cushman Pate 5, fig. 12

**Plectofrondicularia miocenica** Cushman, Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 3, 1926, p. 58, pl. 7, figs. 10-11; pl. 8, figs. 11-12. (Miocene.)

Test much flattened, elliptical in cross section, tapering rapidly to a blunt point at the apical end; edge carinate; chambers ten in a broken specimen, closely appressed, early ones biserial, later ones uniserial; sutures distinct, of clear shell material; wall thin; surface smooth except in the early portion where there are five, short costae which begin on the proloculum and spread and disappear in the next few chambers; aperture terminal, central, oval. Length of broken specimen, 0.35 mm. Rare.

### Family BULIMINIDAE Jones, 1876

### Genus BULIMINA d'Orbigny, 1826

**Bulmina inflata** Seguenza Plate 5, fig. 13

**Bulimina inflata** Seguenza, Atti Accad. Gioenia Sci. Nat., Catania, ser. 2, vol. 13, 1862, p. 109, pl. 1, fig. 10. (Pleistocene.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, 1911, p. 84, fig. 137 a-b. (Recent.)—Cole, Bull. Am. Pal., vol. 14, no. 51, 1927, p. 25, pl. 3, fig. 12. (Eocene.)

Test ovate, tapering to a sharp spine at the apical end; chambers numerous, inflated, rapidly increasing in size as added; wall thick; surface smooth except for crenulations on the lower sides of the chambers which extend beyond the margin forming stout spines; aperture a comma-shaped opening on the inner face of the last-formed chamber, with small, plate-like tooth. Length, 0.52 mm.; breadth, 0.45 mm. Abundant.

### Genus VIRGULINA d'Orbigny, 1826

**Virgulina bramlettei** n. sp. Plate 5, fig. 14

Test elongate, subcylindrical, slightly flattened, apical and apertural ends bluntly pointed; chambers about eight, rapidly increasing in height as added, not inflated, early chambers triserial, later ones biserial; sutures distinct, slightly depressed, of clearer shell material; wall thick, very finely perforate; surface smooth; aperture comma-shaped, at the end of the last chamber. Length, 0.6 mm. Rare.

*Holotype.* Columbia University Paleo. Coll. No. 19960.

This species differs from *V. dibollensis* Cushman and Applin (Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 168, pl. 7, fig. 7), in the longer chambers. It is named for Mr. M. N. Bramlette, who collected the material.

### Family UVIGERINIDAE Galloway and Wissler, 1927

### Genus UVIGERINA d'Orbigny, 1826

**Uvigerina alata** Cushman and Applin Plate 6, fig. 1

**Uvigerina alata** Cushman and Applin, Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 176, pl. 8, figs. 11-13. (Upper Eocene.)

Test fusiform, apical end bluntly rounded or pointed, apertural end truncate; composed of four to five whorls; chambers slightly inflated, three to a whorl, increasing in size as added; sutures depressed; surface ornamented with from twelve to eighteen high costae, which are prominent in the early part, and extend beyond the bases of the chambers, but fade out anteriorly, leaving the last one or two chambers smooth; aperture round, with phialine lip, at the end of a short neck which is situated in a prominent depression. Length, up to 1 mm. Common.

The Ecuador specimens are shorter and the costae are stronger than the Texas specimens of this species.

**Uvigerina beccarii** Fornasini Plate 6, fig. 2

**Uvigerina beccarii** Fornasini, Rendi. Sess. R. Accad. Sci. Isti. Bologna, n. s., vol. 2, 1898, p. 14, pl. 1, fig. 5. (Pliocene.)

Test robust, short, pyriform, apertural end truncate, tapering to a blunt point at the apical end, composed of two or three whorls; chambers slightly inflated, three to a whorl except for the last whorl which has only two chambers; sutures very little depressed and indistinct; surface ornamented in the first third or half, with about six prominent costae which extend across the sutures and between which are small striae; all the costae are irregular and fade out in the last half of the test; wall thick, with secondary layers, white; aperture round, at the end of a short neck, with phialine lip; the neck arises from a depression extending down to the base of the chamber. Length, up to 0.9 mm. Abundant.

The pyriform shape, irregular costae in the early part of the test, and the apertural depression, are characteristic. This species and the one identified as *U. alata* are obviously closely related. Young specimens are globular and striate.

**Uvigerina hispida** Schwager Plate 6, fig. 3

**Uvigerina hispida** Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 249, pl. 7, fig. 95. (Pliocene.)
**Uvigerina auberiana** Brady (not d'Orbigny), Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 579, pl. 75, fig. 9. (Recent.)

Test fusiform, widest near the apical end, composed of about five whorls, three chambers to a whorl in the early part, two to a whorl in the middle and later part; chambers inflated; sutures depressed; surface covered with short, thick spines, not arranged in lines; aperture large, round, at the end of a short neck with phialine lip. Length, up to 1 mm. Abundant.

**Uvigerina proboscidea** Schwager Plate 6, fig. 4

**Uvigerina proboscidea** Schwager, Novara-Exped., Geol., Theil, vol. 2, 1866, p. 250, pl. 7, fig. 96. (Pliocene.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 94, pl. 42, fig. 2. (Recent.)

Test elongate, fusiform or pyriform, composed of four to five whorls, apical end rounded; chambers inflated, arranged triserially except the last whorl which is composed of two chambers; sutures sharply depressed; surface covered with small, short spines, not arranged in any regular manner; aperture terminal, round, at the end of a long neck, with phialine lip. Length, up to 0.76 mm. Abundant.

**Uvigerina pygmaea** d'Orbigny Plate 6, fig. 5

**Uvigerina pigmea** d'Orbigny, Ann., Sci. Nat., vol. 7, 1826, p. 269, pl. 12, figs. 8-9. (Pliocene); Modèles, no. 67, 1826. (Spelled pygmea on explanation of plates.)

Test elongate, fusiform, apical end bluntly rounded; chambers three to a whorl, slightly inflated; sutures distinct, depressed; surface covered with numerous, well-defined costae which are not continuous beyond the suture lines of each chamber, nine or ten on each side of the test, highest in the central portion of the test, lacking in the last few chambers, which are covered with fine, short spines; aperture terminal, round, small, at the end of a long neck, with a slight phialine lip. Length, up to 0.56 mm. Common.

Most species identified as *U. pygmaea* are not that species.

### Family CASSIDULINIDAE d'Orbigny, 1846

### Genus CASSIDULINA d'Orbigny, 1826

**Cassidulina subglobosa** Brady Plate 6, fig. 6

**Cassidulina subglobosa** Brady, Quart. Jour. Micr. Sci., n. s., vol. 21, 1881, p. 60; Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 430, pl. 54, fig. 17 a-c. Sherborn and Chapman, Jour. Roy. Micr. Soc., ser. 2, vol. 6, 1886, p. 744, pl. 16, fig. 2 a-b.—Brady, Parker and Jones, Trans. Zool. Soc. London, vol. 12, ser. 7, 1888, p. 221, pl. 43, figs. 12-14.—Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, 1911, p. 98, fig. 152 a-c. (Recent.)

Test subglobular, irregular in outline, somewhat compressed on both sides; chambers few, inflated, alternating; sutures depressed; wall very finely perforate; surface smooth; aperture a large virguline opening extending up into the last septal face obliquely to the plane of coiling. Diameter, 0.2 - 0.56 mm. Abundant.

### Family PLEUROSTOMELLIDAE Reuss, 1860

### Genus PLEUROSTOMELLA Reuss, 1860

**Pleurostomella alternans** Schwager Plate 6, figs. 7, 8

**Pleurostomella eoceana** Gümbel, Abh. k. bay. Ak. Wiss., München, Math.- 1866, p. 238, pl. 6, figs. 79-80. (Pliocene.)—Brady, Rep. Voy. **Challenger**, Zool., 9, 1884, p. 412, pl. 51, figs. 22-23. (Recent.)—Pummer, Univ. Texas, Bull. 2644, 1926 (1927), p. 69, pl. 4, fig. 2 a-b, (Eocene.)—Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 2, 1927, p. 129, pl. 25, figs. 7-8.

**Pleurostomella eoceana** Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 630, pl. 1, fig. 53 a-b. (Eocene.)

Test elongate, tapering to a blunt point at the apical end; chambers six to ten, rapidly enlarging, longer than broad, the last chamber constituting about a third of the test; biserial and staggered except the initial end of the microspheric form, which is triserial; sutures distinct, deep in the later part of the test; surface smooth; aperture an arched opening with a notch in the lower side, situated in a large depression. Length, 0.28 mm. and 0.59 mm.; breadth, 0.1 mm. and 0.16 mm. Rare.

### Genus NODOSARELLA Rzehak, 1895

Genotype (designated by Cushman, 1928) **Lingulina tuberosa** Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 629, pl. 1, fig. 52, (Eocene, Bavarian Alps.)

**Nodosarella** Rzehak, Ann. k. k. naturhist. Hofmuseums, vol. 10, 1895, p. 220.—Silvestri, Atti Soc. Ital. Sci. Nat., vol. 64, 1925, p. 52—Cushman, Foraminifera, 1928, p. 261.

**Ellipsonodosaria** Silvestri, Atti Rend. R. Accad. Sci. Lett. Arti Zelanti, Acireale, Mem. Cl. Sci., vol. 10, 1900, p. 4; monotype, **Lingulina rotundata** d'Orbigny; Riv. Ital. Pal., anno 29, 1923, p. 15; Boll. Soc. Geol. Ital. Sci. Nat., Mus. Civ. Stor. Nat. Milano, vol. 62, 1923, p. 345.

Test free, elongate, round or nearly so in cross section; chambers several, uniserial, regularly arranged or staggered in the early portion of the test; wall calcareous, hyaline, very finely perforate; surface smooth, costae or spinose; aperture terminal, crescentic, with calcareous grooved column extending downward from the concave side of the aperture. Length, up to 3 mm. Shallow water sediments.—Lower Cretaceous to Pliocene.

*Nodosarella* may be a synonym of *Stilostomella.*

**Nodosarella camerani** (Dervieux) Plate 6, figs. 9-11

**Nodosaria Camerani** Dervieux, Boll. Soc. Geol. Italiana, vol. 12, 1893 (1894), p. 612, pl. 5, figs. 40-41. (Eocene.)

**Ellipsonodosaria Camerani** Silvestri, Riv. Ital. Pal., anno 29, 1923, p. 16, pl. 2, figs. 4-12. (Eocene.)

? **Nodosaria cocoaensis** Cushman, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1925, p. 66, pl. 10, figs. 5-6. (Eocene.)

? **Dentalina cocoaensis** Cushman, Jour. Pal., vol. 1, no. 2, 1927, p. 153, pl. 24, fig. 14. (Lower Oligocene, Alazan shale.)

Test elongate, subcylindrical, curved, with one or two short, eccentrically placed apical spines; chambers nine to fourteen, gradually enlarging in the microspheric form, of about equal size in the megaspheric form; sutures distinct, not oblique, of clear shell material, flush in the early part but constricted between the later chambers; wall thick of concentric layers, surface smooth; aperture terminal, kidney shaped, with vertical tooth. Length, up to 3 mm. Abundant.

We consider this species the most important one in the fauna as indicating the age of the fauna. The Ecuador specimens seem to be identical with the Italian ones, although the specimens vary much in details. It seems probably that *Nodosaria cocoaensis* Cushman of the Upper Eocene of Alabama and Lower Oligocene of Mexico is the same species. He does not mention the aperture.

*Nodosaria camerani* (Dervieux) cannot be the genotype of *Siphonodosaria,* as stated by Cushman, Foraminifera, 1928, p. 257, for Silvestri distinctly states (Boll. Soc. Geol. Ital., vol. 42, 1923 (1924), p. 18) that he considers it an *Ellipsonodosaria.*

**Nodosarella paucistriata** n. sp. Plate 6, fig. 12

Test elongate, subcylindrical, tapering, curved; chambers six or seven in a broken specimen, bulbous, gradually enlarging; sutures constricted, crossed by short striae, which become obsolescent on the middle of the chambers; wall thick, finely perforate, composed of concentric layers; surface smooth; aperture terminal, produced, kidney-shaped, sometimes with tooth. Length, up to 1.8 mm. Abundant.

*Holotype.* Columbia University Paleo. Coll. No. 19961.

The striae across the sutures in this form seem to make it a new species, as no striate or costate species have been described. This species is like *Nodosaria tholigera* Schwager except for the round, radiate aperture in that form.

### Genus DAUCINA Bornemann, 1855

Genotype (monotypic) **Daucina ermaniana** Bornemann, Erman's Archiv. Wiss. Kunde Russland, vol. 14, 1855, pp. 153-154, pl. 1, figs. 5-15. (Tertiary, near Rio de Janeiro at Corcovado.)

**Ellipsoglandulina** Silvestri, Atti Rend. R. Accad. Sci. Lett. Arti Zelanti, Acireale, Mem. Cl. Sci., vol. 10, 1900, p. 9, pl. figs. 3-10, 12, 13. (Miocene or Pliocene, Zanclean, Borfornello, Termini-Imerese, Sicily.)—Silvestri, Atti R. Accad. Sci. Torino, vol. 38, 1903, p. 213; Atti Soc. Ital. Sci. Nat., vol. 64, 1925, p. 51, fig. 2.

Test free, oval; chambers several, arranged in a rectilinear manner or curved in the early portion of the test, rapidly enlarging, each embracing much of the previous one; wall calcareous, finely perforate, smooth or costate; aperture terminal, crescentic, with or without notch in the concave side, with internal column. Length, up to 2 mm.—Shallow water deposits.—Cretaceous and Eocene of Mexico; Tertiary of Brazil; Oligocene to Pliocene of Italy.

**Daucina multicostata** n. sp. Plate 6, fig. 13

Test straight, except for the apical end which is curved, tapering, initial end sharply pointed; chambers four to six, early ones compressed, later ones bulbous and distinct; sutures depressed; surface throughout ornamented with eighteen to twenty-two fine, longitudinal costae which cease near the middle of the last chamber; aperture terminal, crescentic. Length, 0.46 - 0.8 mm. Common.

*Holotype.* Columbia University Paleo. Coll. No. 19962.

This species is the only costae one of the genus so far known.

### Genus ELLIPSOLAGENA Silvestri, 1924

**Ellipsolagena ventricosa** (Silvestri) Plate 6, fig. 14

**Lagena ventricosa** Silvestri, Atti R. Accad. Sci. Torino, vol. 39, 1903, pp. 10-11, fig. 6 a-e. (Miocene.)

**Ellipsolagena ventricosa** Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 3, pt. 1, 1927, p. 71, pl. 15, fig. 10.

Test spherical, circular in side view, broadly elliptical in apertural view, with a short apical spine; wall hyaline, very finely perforate; surface smooth except for a short raised keel at the apertural end; aperture an elliptical slit just below the keel, with an internal tube. Length, 0.26 mm.; breadth, 0.22 mm. Rare.

This species somewhat resembles *Lagena apiculata* Brady (not Reuss) Rep. Voy. *Challenger,* Zool., vol. 9, 1884, p. 453, pl. 56, figs. 15-18, which is an *Ellipsolagena,* but differs in being more perfectly spherical.

## Family NONIONIDAE Reuss, 1860

### Genus NONION Montfort, 1808

**Nonion pompilioides** (Fichtel and Moll) Plate 6, fig. 15

**Nautilus pompilioides** Fichtel and Moll, Test. Micr. 1798, p. 31, pl. 2, figs. a-c. (Pliocene-Recent)

**Nonionina pompilioides** Brady, Rep. Voy. **Challenger**, Zool., vol. 9, 1884, p. 727, pl. 109, figs. 10-11. (Recent.)

Test bilaterally symmetrical, subcircular in side view, oval in face view, deeply umbilicate, axial diameter increasing slowly; chambers eight to nine in the last whorl; sutures distinct, of clear shell material, not depressed; wall conspicuously perforate; aperture a long narrow slit on the inner margin of the last septal face, with slight lip. Diameter, 0.21 - 0.5 mm. Abundant.

This species differs from *N. umbilicata* (d'Orbigny) in the fewer chambers and greater diameter of the early whorls.

### Genus PULLENIA Parker and Jones, 1862

**Pullenia bulloides** (d'Orbigny) Plate 6, fig. 16

**Nonionina bulloides** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 293, no. 2; Foram. Foss. Bass. Tert. Vienne, 1846, p. 107, pl. 5, figs. 9-10. (Miocene.)

Test spheroidal, bilaterally symmetrical, axial diameter nearly or quite equal to the equatorial; chambers four in the last whorl; sutures narrow, distinct, straight or slightly curved and radial, as seen from the side of the test; wall very finely perforate; surface smooth; aperture a narrow slit at the base of the last septal face. Diameter, up to 0.38 mm. Abundant.

**Pullenia quinqueloba** (Reuss) Plate 6, fig. 17

**Nonionina quinqueloba** Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 71, pl. 5, fig. 31. (Middle Oligocene.)

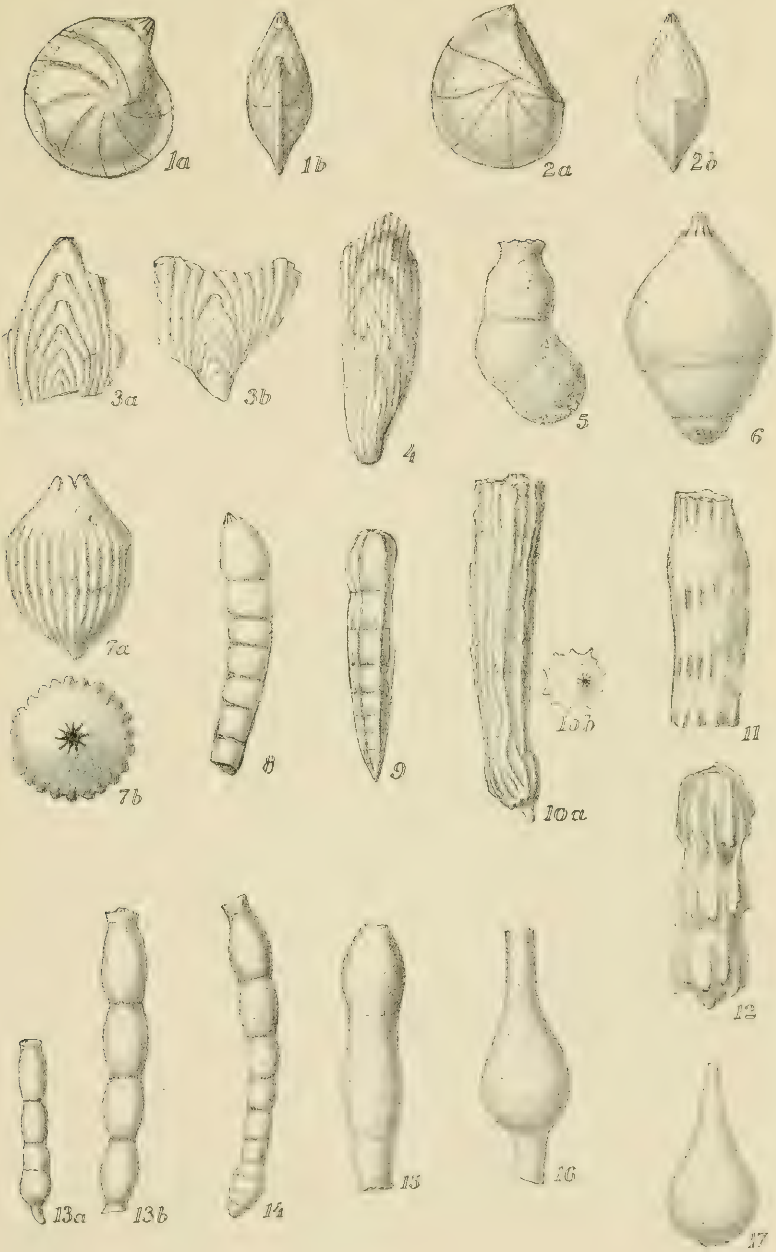
**Pullenia quinqueloba** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, 1884, p. 617, pl. 84, figs. 14-15. (Recent.)—Brady, Parker and Jones, Trans. Zool. Soc. London, vol. 12, pt. 7, 1888, p. 226, pl. 43. figs. 22-23. (Recent.)—Franke, Abh. Ber. Mus. Natur. Heimatk., Naturw. Ver. Magdeburg, vol. 4, pt. 2, 1925, p. 188, pl. 6, fig. 70. (Lower Oligocene.)

Test nautiloid, biconvex, somewhat compressed; periphery slightly lobulate; peripheral margin broadly rounded; chambers five in the last whorl; sutures slightly depressed and curved; surface smooth and glossy; aperture a long, narrow slit at the base of the last septal face, with upper lip. Diameter, 0.3 mm.; breadth, 0.2 mm. Rare.

## PLATES 1 - 6

## EXPLANATION OF PLATE 1

| FIGURE | | PAGE |
|---|---|---|
| 1 a, b. | —**Lenticulina occidentalis novangliae** (Cushman), x 32. **a**, side view; b, face view. | 11 |
| 2 a, b. | —**Lenticulina theta** Cole, x 48. **a**, side view; **b**, face view. | 11 |
| 3 a, b. | —**Flabellina budensis** Hantken, x 37. a, later portion of a specimen. b, apical end of a megaspheric one. | 11 |
| 4. | —**Frondicularia striata** d'Orbigny, x 30. | 12 |
| 5. | —**Marginulina** sp., x 37. | 12 |
| 6. | —**Glandulina laevigata** (d'Orbigny), x 32. | 12 |
| 7 a, b. | —**Glandulina comata** (Batsch), x 36. **a**. side view; **b**. apertural view. | 13 |
| 8. | —**Dentalina pauperata** d'Orbigny, x 22. Later portion of an elongate specimen. | 13 |
| 9. | —**Nodosaria acuminata** Hantken, x 41. | 14 |
| 10 a, b. | —**Nodosaria vertebralis** (Batsch), x 36. **a**, side view; **b**, apertural view. | 14 |
| 11. | —**Nodosaria obliquestriata** (Reuss), x 44. | 14 |
| 12. | —**Nodosaria** sp. Cole, x 50. | 15 |
| 13 a, b. | —**Nodosaria consobrina** (d'Orbigny), x 35. **a**, early portion of a specimen; **b**, middle portion of a specimen. | 15 |
| 14. | —**Nodosaria emaciata** (Reuss), x 46. | 15 |
| 15. | —**Nodosaria arundinea** Schwager, x 40. | 16 |
| 16. | —**Nodosaria pyrula** of authors, x 26. | 16 |
| 17. | —**Nodosaria** sp., x 30. | 16 |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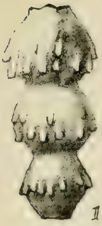
17

## EXPLANATION OF PLATE 2

| FIGURE | | PAGE |
|---|---|---|
| 1. | —**Nodosaria adolphina** (d'Orbigny), x 70. | 16 |
| 2. | —**Nodosaria lepidula** Schwager, x 68. | 17 |
| 3. | —**Nodosaria annulifera** Gümbel, x 110. | 17 |
| 4. | —**Nodosaria holserica** Schwager, x 58. | 17 |
| 5. | —**Nodosaria conspurcata** Reuss, x 54. | 18 |
| 6. | —**Lagena asperoides** n. sp., x 47. | 19 |
| 7. | —**Lagena semistriata** Williamson, x 45. | 19 |
| 8. | —**Lagena strumosa** Reuss, x 60. | 20 |
| 9. | —**Lagena sulcata apiculata** Cushman, x 70. | 20 |
| 10 **a, b.** | —**Robulus calcar** (Linné), x 35. **a,** side view; **b,** apertural view. | 20 |
| 11 **a, b.** | —**Robulus** cf. **deformis** (Reuss), x 50 **a,** apertural view; **b,** side view of an other specimen. | 21 |
| 12. | —**Robulus deformis** (Reuss) var., x 40. | 21 |
| 13 **a, b.** | —**Robulus duracina** (Stache), x 33. **a,** side view; **b,** apertural view. | 21 |
| 14 **a, b.** | —**Robulus taettowata** (Stache), x 20. **a,** side view; **b,** apertural view. | 21 |
| 15 **a, b.** | —**Fissurina carinata** Reuss, x 86. **a,** side view; **b,** edge view. | 22 |
| 16. | —**Fissurina globosa** Bornemann, x 78. | 22 |
| 17 **a, b.** | —**Fissurina orbignyana caribaea** (Cushman), x 50. **a,** side view; b, edge view. | 22 |
| 18 **a, b.** | —**Fissurina staphyllearia** Schwager, x 60. **a,** side view; **b,** edge view. | 23 |
| 19. | —**Fissurina sp.,** x 40. | 23 |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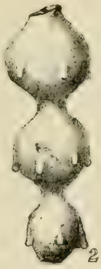
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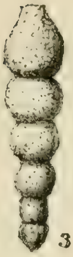
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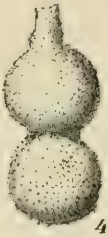
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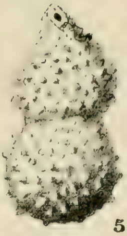
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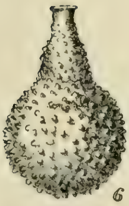
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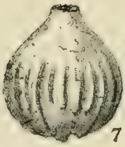
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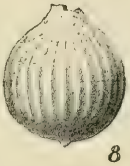
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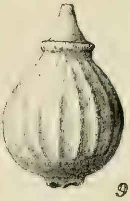
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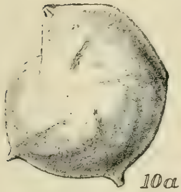
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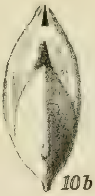
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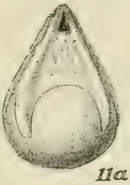
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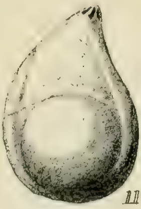
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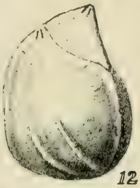
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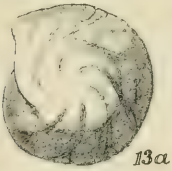
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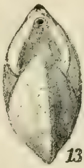
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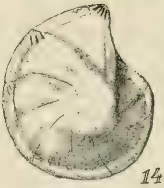
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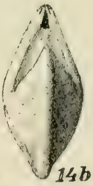
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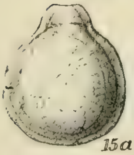
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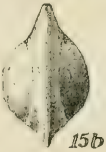
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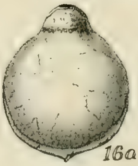
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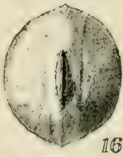
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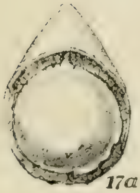
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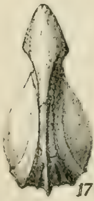
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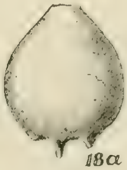
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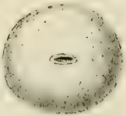
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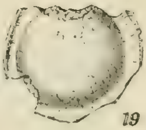
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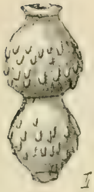
## EXPLANATION OF PLATE 3

| FIGURE | | PAGE |
|---|---|---|
| 1. | —**Lagenonodosaria monilis** (Silvestri), x 48. | 18 |
| 2 a, b. | —**Lingulina** sp., x 100. **a**, side view; **b**, apertural view. | 23 |
| 3 a, b. | —**Quinqueloculina angusta** (Philippi), x 50. **a**, **b**, side views. | 8 |
| 4. | —**Sigmoilina celata** (Costa), x 27. | 8 |
| 5 a, b. | —**Globigerina bulloides** d'Orbigny, x 80. **a**, dorsal view; **b**, ventral view. | 9 |
| 6 a - c. | —**Globigerina compressa** Plummer, x 80. **a**, dorsal view; **b**, side view; **c**, ventral view. | 9 |
| 7 a - c. | —**Globigerina conglomerata** Schwager, x 37. **a**, dorsal view; **b**, side view; **c**, ventral view. | 9 |
| 8 a - c. | —**Globigerina pseudobulloides** Plummer, x 75. **a**, dorsal view; **b**, side view; **c**, ventral view. | 10 |
| 9 a, b. | —**Globigerina trilocularis** d'Orbigny, x 70. **a**, dorsal view; **b**, ventral view. | 10 |
| 10. | —**Globulina ovata** d'Orbigny, x 53. | 24 |
| 11 a - c. | —**Globorotalia canariensis** d'Orbigny, x 56. **a**, dorsal view; **b**, edge view; **c**, ventral view. | 25 |
| 12 a - c. | —**Rotalia advena** Cushman, x 60. **a**, dorsal view; **b**, edge view; **c**, ventral view. | 25 |
| 13 a - c. | —**Rotalia ecuadorensis** n. sp., x 50. **a**, dorsal view; **b**, edge view; **c**, ventral view. | 26 |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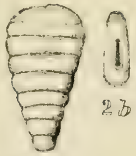
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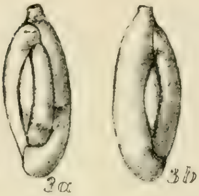
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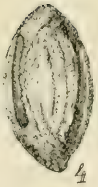
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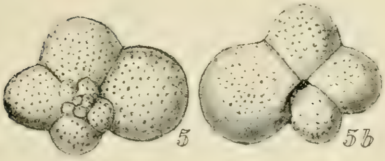
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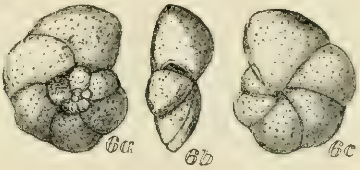
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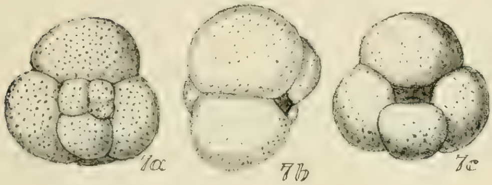
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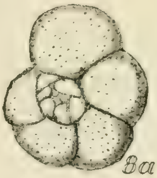
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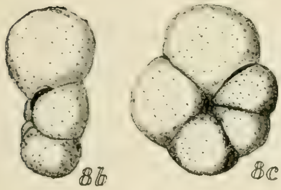
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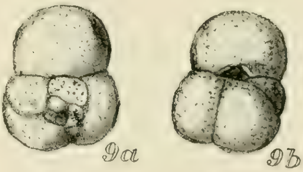
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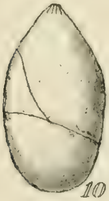
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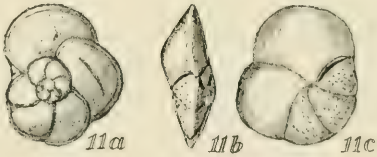
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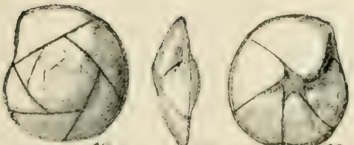
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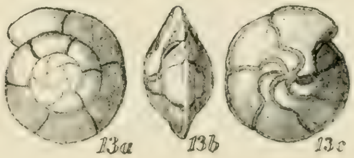
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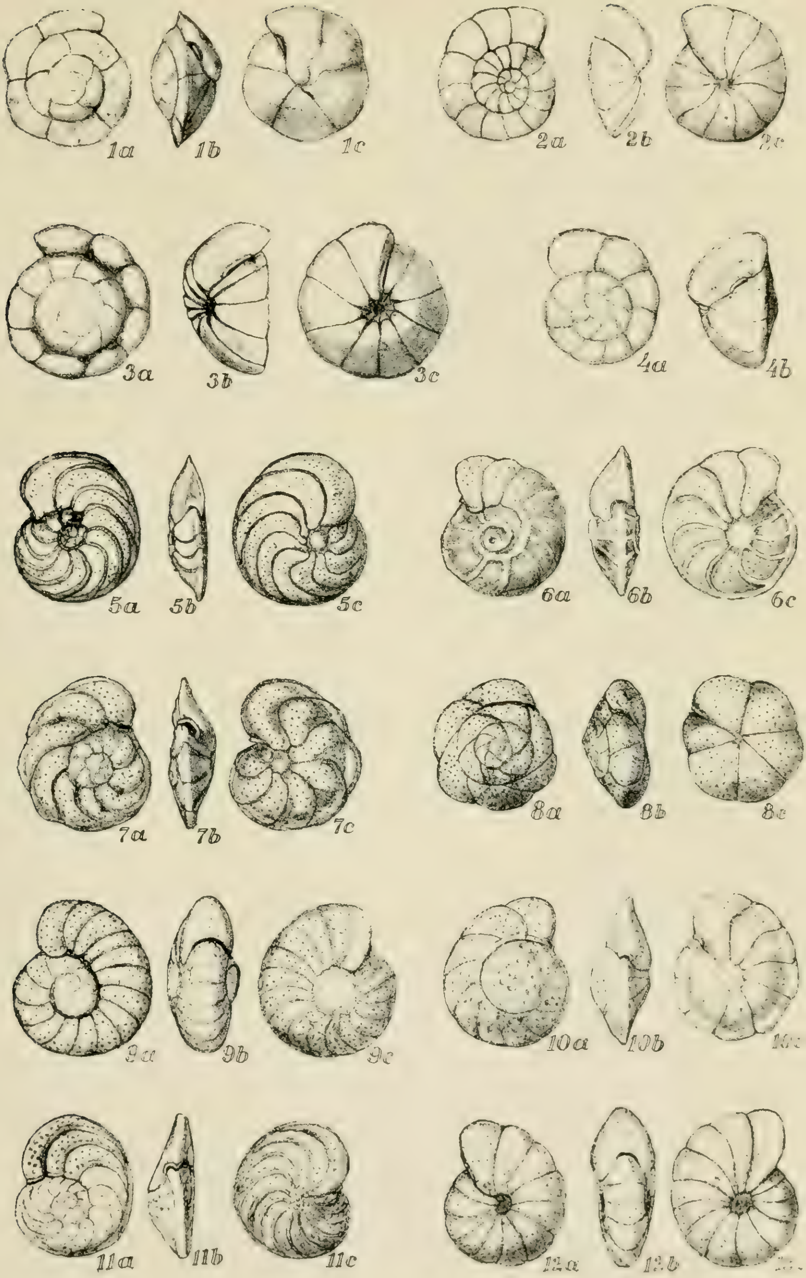
## EXPLANATION OF PLATE 4

| FIGURE | | PAGE |
|---|---|---|
| 1 a - c. | —**Rotalia umbonata** (Reuss), x 34. a, dorsal view; b, edge view; c, ventral view. | 26 |
| 2 a - c. | —**Gyroidina laevis** d'Orbigny, x 50. a, dorsal view; b, edge view; c, ventral view. | 27 |
| 3 a - c. | —**Gyroidina nitidula** (Schwager), x 28. a, dorsal view; b, edge view; c, ventral view. | 27 |
| 4 a, b. | —**Gyroidina soldanii** d'Orbigny, x 55. a, dorsal view; b, edge view. | 27 |
| 5 a - c. | —**Anomalina mantaensis** n. sp., x 54. a, dorsal view; b, edge view; c, ventral view. | 28 |
| 6 a - c. | —**Cibicides alleni** (Plummer), x 20. a, dorsal view; b, edge view; c, ventral view. | 29 |
| 7 a - c. | —**Cibicides dohertyi** n. sp., x 33. a, dorsal view; b, edge view; c, ventral view. | 30 |
| 8 a - c. | —**Cibicides haidingerii** (d'Orbigny), x 50. a, dorsal view; b, edge view; c, ventral view. | 30 |
| 9 a - c. | —**Cibicides nuculeata** (Seguenza), x 20. a, dorsal view; b, edge view; c, ventral view. | 31 |
| 10 a - c. | —**Cibicides ungeriana** (d'Orbigny), x 37. a, dorsal view; b, edge view; c, ventral view. | 31 |
| 11 a - c. | —**Cibicides wuellerstorfi** (Schwager), x 28. a, dorsal view; b, edge view; c, ventral view. | 31 |
| 12 a - c. | —**Planulina affinis** (Hantken), x 50. a, dorsal view; b, edge view; c. ventral view. | 32 |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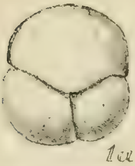
11a
11b
11c
12a
12b
12c

## EXPLANATION OF PLATE 5

| FIGURE | | PAGE |
|---|---|---|
| 1 a, b. | —**Sphaeroidina bulloides** var. **chilostomata** n. var., x 46. **a**, dorsal view; **b**, ventral view. | 32 |
| 2. | —**Verneuilina cyclostomata** n. sp., x 33. | 33 |
| 3 a, b. | —**Gaudryina globulifera** Reuss, x 55. **a**, side view; **b**, apertural view. | 33 |
| 4 a, b. | —**Gaudryina globulifera** Reuss, x 60. Young specimen. **a**, **b**, side views. | 33 |
| 5 a, b. | —**Clavulina curta** n. sp., x 22. **a**, side view; **b**, apertural view. | 34 |
| 6 a, b. | —**Clavulina pallida** Cushman, x 21. **a**, side view; **b**, apertural view. | 34 |
| 7. | —**Clavulina pallida** Cushman, x 21. Broken specimen. | 34 |
| 8 a, b. | —**Textularia flabelliformis** Gümbel, x 27. **a**, side view; **b**, apertural view. | 35 |
| 9 a, b. | —**Bolivina applinae** Plummer, x 108. **a**, side view; **b**, edge view. | 35 |
| 10 a, b. | —**Bolivina pisciformis** n. sp., x 45. **a**, side view; **b**, apertural view. | 36 |
| 11 a, b. | —**Plectofrondicularia californica** Cushman and Stewart, x 32. **a**, side view; **b**, apertural view. | 36 |
| 12. | —**Plectofrondicularia miocenica** Cushman, x 60. | 37 |
| 13. | —**Bulimina inflata** Seguenza, x 40. | 37 |
| 14 a, b. | —**Virgulina bramlettei** n. sp., x 54. **a**, side view; **b**, apertural view. | 37 |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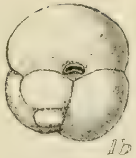
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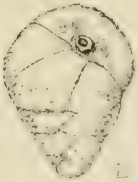
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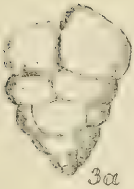
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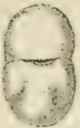
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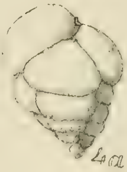
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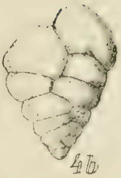
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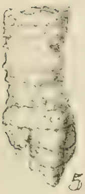
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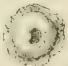
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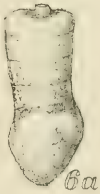
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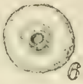
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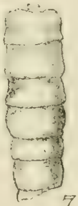
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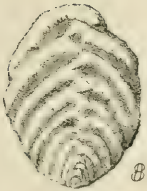
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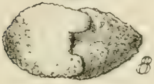
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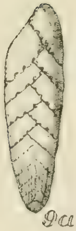
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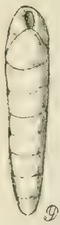
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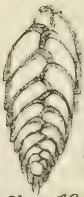
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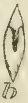
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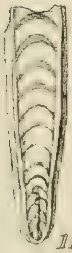
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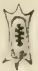
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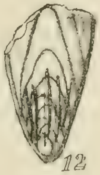
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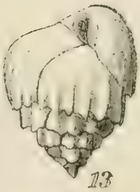
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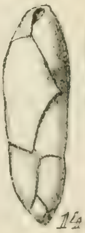
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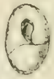
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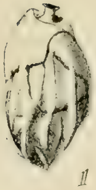
## EXPLANATION OF PLATE 6

| FIGURE | | PAGE |
|---|---|---|
| 1. | —**Uvigerina alata** d'Orbigny, x 30. | 38 |
| 2. | —**Uvigerina beccarii** Fornasini, x 30. | 38 |
| 3. | —**Uvigerina hispida** Schwager, x 34. | 39 |
| 4. | —**Uvigerina proboscidea** Schwager, x 45. | 39 |
| 5. | —**Uvigerina pygmaea** d'Orbigny, x 50. | 39 |
| 6 **a, b.** | —**Cassidulina subglobosa** Brady, x 48. **a**, apertural view; **b**, edge view. | 40 |
| 7. | —**Pleurostomella alternans** Schwager, x 86. Megaspheric specimen. | 40 |
| 8. | —**Pleurostomella alternans** Schwager, x 50. Broken microspheric specimen. | 40 |
| 9 **a, b.** | —**Nodosarella camerani** (Dervieux), x 12. Megaspheric specimen. **a**, side view; **b**, apertural view. | 41 |
| 10 **a, b.** | —**Nodosarella camerani** (Dervieux), Megaspheric specimen. **a**, side view, x 11. **b**, apertural view, x 15. | 41 |
| 11. | —**Nodosarella camerani** (Dervieux), x 18. Microspheric specimen. | 41 |
| 12 **a, b.** | —**Nodosarella paucistriata** n. sp., x 17. **a**, side view; **b**, apertural view. | 42 |
| 13 **a, b.** | —**Daucina multicostata** n. sp., x 32. **a**, side view; **b**, apertural view. | 42 |
| 14 **a, b.** | —**Ellipsolagena ventricosta** (Silvestri), x 63. **a**, edge view; **b**, side view. | 43 |
| 15 **a, b.** | —**Nonion pompilioides** (Fichtel and Moll), x 50. **a**, edge view; **b**, side view. | 43 |
| 16 **a, b.** | —**Pullenia bulloides** (d'Orbigny), x 80. **a**, side view; **b**, edge view. | 43 |
| 17 **a, b.** | —**Pullenia quinqueloba** (Reuss), x 70. **a**, side view; **b**, edge view. | 44 |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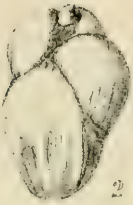
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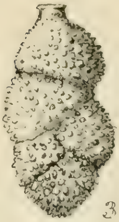
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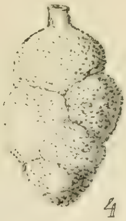
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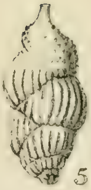
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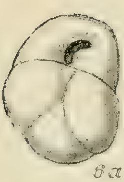
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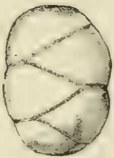
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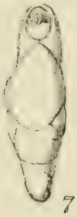
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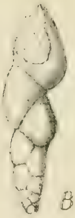
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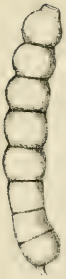
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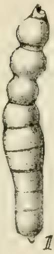
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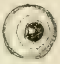
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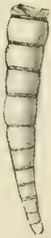
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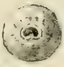
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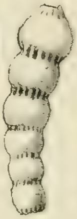
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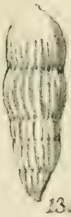
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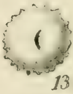
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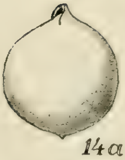
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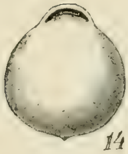
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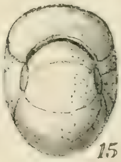
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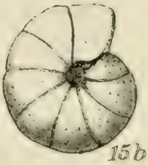
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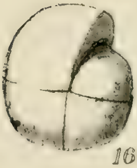
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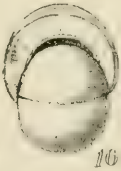
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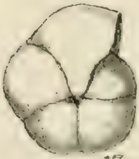
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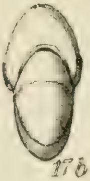
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BULLETINS
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Vol. 15

## No. 56

# THREE NEW CLAIBORNE FOSSILS

By W. Storrs Cole

*March 14, 1929*

Harris Co.
Ithaca, N.Y.
U. S. A.

# THREE NEW CLAIBORNE FOSSILS

## Introduction

The material in which the new forms described in this paper were found, was collected by Mr. A. C. Veatch during his survey of the Sabine River, in the year 1900. (See Louisiana Geol. Surv., Report of 1902.)

The matrix is a fossiliferous, oolitic, green sand which weathers to a dark, reddish brown. It contains many small Molluscs which are in an exceedingly poor state of preservation. There are a few which retain enough of their characteristics to permit specific determination. It is on these, that I am basing my stratigraphic deductions.

*Lepidocyclina* (*Polylepidina*) *gardneræ* Cole, n. sp. is very abundant, but *Operculinella sabinensis* Cole, n. sp. and *Mytilus gilbertharrisi* Cole, n. sp. are represented by only a few specimens. Because of the great number of individuals of this species of *Lepidocyclina,* together with its considerably better state of preservation than the other fossils from this horizon, it should make a good stratigraphic marker for these beds.

Only one horizon is represented by the samples which I have, so nothing can be said in regard to the probable vertical or horizontal distribution of these species. No other Foraminifera have been found up to this date from the material now at hand.

Dr. Vaughan, who kindly examined specimens of *L. gardneræ* for me and to whom I owe my thanks for checking this manuscript, suggested that this species is very similar to sections he has of *L. antillea* Cushman, but not identical with it. At the same time he very kindly sent me a carbon copy of an article of his on the nomenclature of *Lepidocyclina* which is to appear in the March number of the Journal of Paleontology.

After reading this article with considerable care, I am convinced that Vaughan offers enough proof, so that the well-known name *Lepidocyclina* should be retained, in preference to *Cyclosiphon.*

## DESCRIPTION OF SPECIES

### Order FORAMINIFERA d'Orbigny

### Genus LEPIDOCYCLINA Gümbel

### Subgenus POLYLEPIDINA Vaughan

**Lepidocyclina (Polylepidina) gardneræ** Cole, n. sp.
Plate 1, figs. 1 - 6; Plate 2, figs. 1, 2

Test circular, not sellæform, varying from biconvex to plano-convex, most specimens being biconvex; pustulate, the pustules being particularly numerous in the umbilical region. The largest specimen measured 8.2 mm. in diameter and is a microspheric form; the smallest specimen measured 2.8 mm. and is a megalospheric specimen. The average diameter is about 6 mm. Thickness through the center averages about 1.3 mm. in microspheric forms.

Most specimens do not exhibit a distinct umbonate area, rather an even thinning from a central high point to the periphery. Some few specimens, however, have a distinct raised portion which is demarked from the remainder of the test by a definite line. This raised portion when present, occupies about one-half the total surface area of the test.

In horizontal section, the median chambers arcuate, with the outer wall curved and usually with slightly truncated proximal ends.

In vertical section, the lateral chambers appear irregular, both as to size and spacing. In some specimens the lateral chambers appear to be missing, due to the fact that the chamber walls are directly superimposed with cavity between, missing. When the lateral chambers are present, they appear to be about 3 times as long as wide. There is generally a layer of shell material between the rows of lateral chambers when they are present which is about twice as wide as the chambers, themselves. The pillars whose outer ends represent the pustules are distinctly present in all sections. The line of equatorial chambers is distinct, the chambers in the center being the smallest, growing gradually larger as they reach the periphery, altho they never occupy the entire width of the test.

The nucleoconch of the megalospheric form, consists generally of 5 chambers, a large one with four smaller ones partially surrounding it. The entire embryonic apparatus is roughly circular in shape with the chambers which surround the large central one gradually decreasing in size until they form the true equatorial chambers. The diameter of the large central chamber is 0.231 mm.; the diameter of the entire nucleoconch is 0.33 mm. Walls of the embyronic chambers thicker than those of the median chambers.

In horizontal sections of the microspheric forms, the nucleoconch is coiled, the chambers gradually enlarging, making about three and one-half volutions. In most sections examined, of microspheric specimens, the nucleoconch seems to form a cone which appears rather distinctly from one side or the other of the section. The apex of the cone is formed by the initial chamber. Whether this is globular or not, I have not been able to decide. By the time the embryonic chambers have reached the general plane of the equatorial chambers, they have become full-sized equatorial chambers. The equatorial chambers gradually increase in size as they approach the periphery of the test.

The chamber wall is composed of three distinct parts, a dark inner portion bordered by lighter outer portions. The dark inner portion is wider than the combined width of the lighter portions.

There appear to be 3 openings which occur in the corners of each chamber.

*L. antillea* as suggested by Dr. Vaughan, appears to be the nearest to this new form. The embryonic apparatus of *L. antillea* has not been published to date. For a comparison, therefore, the most striking differences appear in the vertical sections. *L. antillea* in the published vertical section has large, easily recognized lateral chambers and slightly different appearing median chambers. *L. antillea* also is reported to have about 6 layers of lateral chambers, but *L. gardneræ* has only 4 when they are present.

*Locality.*— Cooper's Mill, one and one-half miles south of Sabinetown, Texas.

*Cotypes.*— My personal collection.
*Horizon.*— St. Maurice Eocene.

Associated with *L. gardneræ* are the following Mollusca:

*Ostrea vicksburgensis ludoviciana* Harris (common)
*Amussium squamulum* Lam. (abundant)
*Semele linosa*, var. (see Bull. Amer. Pal., vol. VI, No. 31, p. 171, pl. 52, fig. 5a, 1919) (very rare)
*Arca rhomboidella* Lea (rare)
*Venericardia rotunda funiculus* Harris (or very near this variety)
*Natica* (*Neverita*) *limula* Conrad
*Mytilus gilbertharrisi* Cole, n. sp.; and one coral:
*Endopachys maclurii tenue* Vaughan

This species is named in honor of Dr. Julia Gardner of the U. S. Geological Survey, Washington, D. C.

### Genus OPERCULINELLA Yabe

**Operculinella sabinensis** Cole, n. sp. Plate 2, figs. 5, 6

Test small, biconvex, consisting of 24 - 26 chambers in the final volution. Thickest in the umbilical area, gradually thinning to the periphery which is bluntly rounded. Surface and sutures without ornamentation except for a very few small raised clear beads of shell material directly over the umbilicus. Sutures show only indistinctly through the shell wall. Sutures distinctly arcuate and wavy. About 5 volutions comprise an adult test.

Diameters nearly equal 3.6 mm.

*Locality.*— Cooper's Mill, one and one-half miles south of Sabinetown, Texas.

*Cotypes.*— My personal collection.

*Horizon.*— Horizon of *L. gardneræ*, St. Maurice Eocene,

This species is nearest *O. willcoxi* (Heilprin) from the Ocala limestone, but differs in the smaller number of chambers, smaller size and greater wave-like appearance of the sutures.

### Order PRIONODESMACEA Dall

### Genus MYTILUS Linn.

**Mytilus gilbertharrisi** Cole, n. sp. Plate 2, figs. 3, 4

Shell elongated, oblong. Beaks terminal, small; umbones prominent, though small; posterior end regularly rounded; anterior end also fairly regularly rounded, almost as broad as the posterior end; cardinal margin straight with a channel-like depression extending between this margin and the umbonal ridge; umbonal ridge slightly prominent. Surface with numerous indistinct, radiating striæ.

Length from beak to lower posterior margin 12 mm.
Width at a right angle to this measurement 7.5 mm.
Depth of valve 4 mm.

*Holotype.*— Personal collection of G. D. Harris.

*Horizon.*— Horizon of *L. gardneræ,* St. Maurice Eocene.

*Locality.*— Cooper's Mill, one and one-half miles south of Sabinetown, Texas.

This rather unusual *Mytilus* is named in honor of Prof. G. D. Harris of Cornell University.

# EXPLANATION OF PLATES*

## EXPLANATION OF PLATE 1

| FIG. | PAGE |
|---|---|
| **Lepidocyclina (Polylepidina) gardneræ** Cole, n. sp. | Page 4 |

Cotypes from Cooper's Mill, one and one-half miles south of Sabinetown, Texas.

1. Vertical section of a microspheric form, showing the irregular and occasional development of the lateral chambers; x 17.
2. Vertical section of a microspheric form, showing the lack of lateral chambers, but the strong development of pillars; x 10.5.
3. Vertical section of an extremely lenticular individual; x 10.
4. Horizontal section of a microspheric form, showing the initial coiling and gradual enlargment in size of the equatorial chambers as they approach the periphery; x 10.5.
5. Horizontal section of a megalospheric form, showing the development of the embryonic apparatus and equatorial chambers; x 28.
6. External view, showing relation and size of pustules; x 10.

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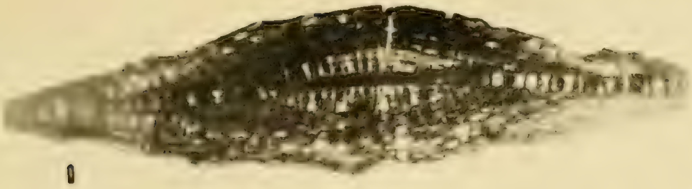
*Author and publisher have shared equally in the expense of plates.



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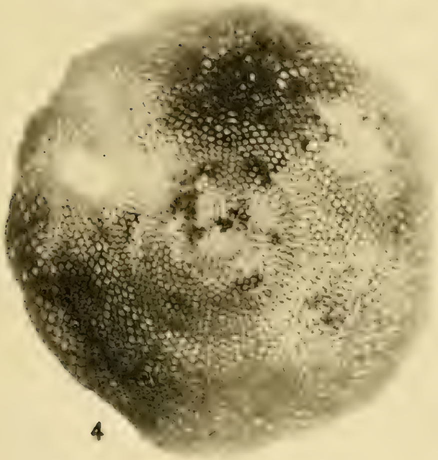

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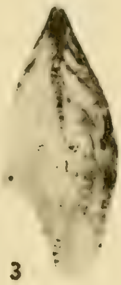

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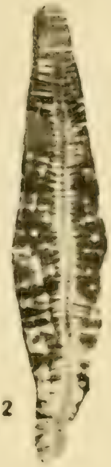

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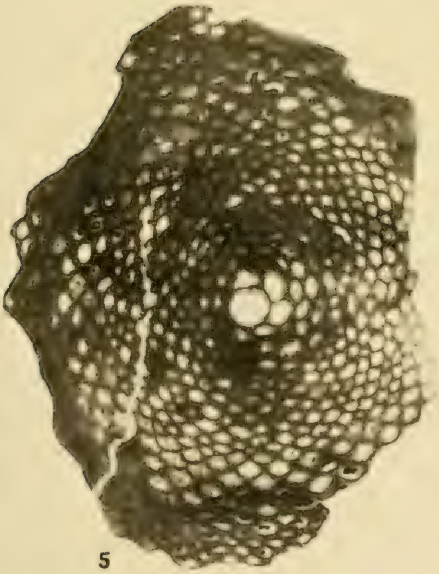

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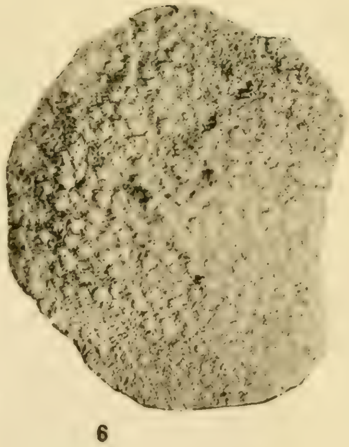

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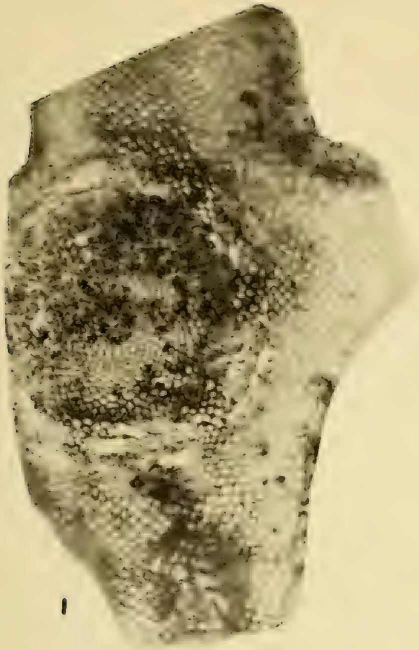
PLATE II

## Explanation of Plate 2

| Fig. | | Page |
|---|---|---|
| 1. | **Lepidocyclina (Polylepidina) gardneræ** Cole, n. sp.; horizontal section of a microspheric form, showing initial coiling and equatorial chambers; cotype; x 10 | 4 |
| 2. | **Lepidocyclina (Polylepidina) gardneræ** Cole, n. sp.; horizontal section of a megalospheric form, showing the embryonic apparatus; cotype; x28 | 4 |
| 3. | **Mytilus gilbertharrisi** Cole, n. sp.; holotype; x 2.6 | 6 |
| 4. | **Mytilus gilbertharrisi** Cole, n. sp.; holotype; x2.6 | 6 |
| 5. | **Operculinella sabinensis** Cole, n. sp.; side view, showing the sutures; cotype; x10 | 6 |
| 6. | **Operculinella sabinensis** Cole, n. sp.; section showing coils and arrangement of chambers; cotype; x10 | 6 |



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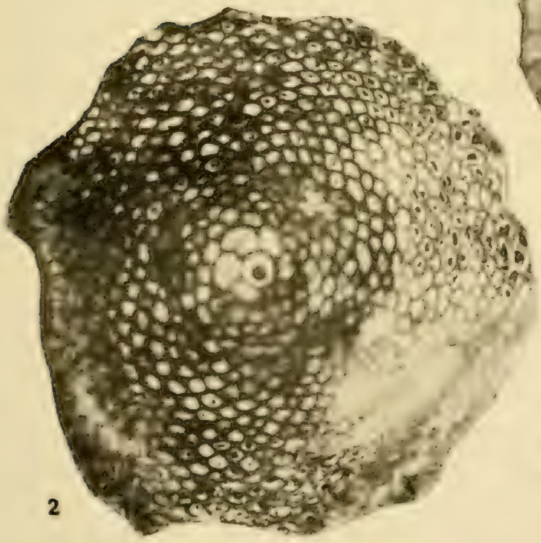

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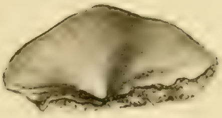

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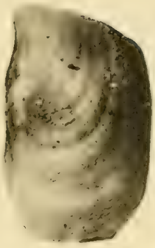

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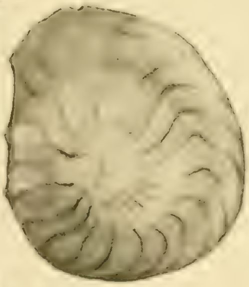

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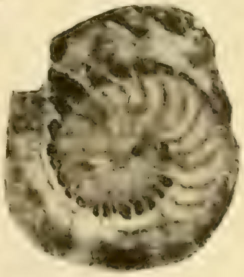

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Vol. 15

# No. 57

# CONTRIBUTIONS TO THE TERTIARY PALEONTOLOGY OF NORTHERN PERU:

## Part 2, Upper Eocene Mollusca and Brachiopoda

By A. A. Olsson

*May 24, 1929*

Harris Co.
Ithaca, N.Y.
U. S. A

## PREFATORY NOTE

The following report, dealing with Eocene Mollusca and Brachiopoda is a continuation of the Contributions to the Tertiary Paleontology of Northern Peru, began in Volume XIV, No. 52, of these Bulletins. The following new genera and subgenera are proposed in this paper.

*Boggsia.* Type: *Turritella anceps* Woods.
*Woodsalia.* (Subgenus of *Mesalia*). Type *Turritella negritosensis* Woods
*Iddingsia.* (Subgenus of *Cerithium*). Type: *Cerithium læviusculum* Gabb
*Perucerithium.* (Subgenus of *Cerithium*). Type: *Cerithium restinense* n. sp.
*Hopkinsiana.* (Subgenus of *Rhinoclavis*). Type: *Morgana costata* Woods
*Lagunitus.* Type: *Telescopium peruvianum* Woods
*Harrisianella.* Type: *Harrisianella pervuviana,* n. sp.
*Peruficus.* Type: *Peruficus lagunitensis,* n. sp.
*Andicula.* Type: *Surcula occidentalis* Woods

Gloversville, N. Y.
January 1st, 1929.

# DESCRIPTION OF SPECIES

### Class PELECYPODA

### Order PRIONODESMACEA Dall

### Superfamily ARCACEA Deshayes

### Family ARCIDÆ Dall

### Genus ARCA (Linnæus) Lamarck

### Subgenus BARBATIA Gray

**Arca (Barbatia) saladoensis**, n. sp. Plate 1, figs. 1, 3

Shell small, thin, inequivale, elongate subrhomboidal and finely sculptured; the outline is elongate subrhomboidal, the hinge and basal margin being nearly parallel with the posterior side but little wider; posterior side straight or slightly irregular, meeting the basal and hinge margins at 90 degree angles; anterior side slightly rounded; the right valve has a sharp, pronounced umbonal ridge bordered on the anterior side by a wide, depressed medial zone or sinus, deepest on the umbo, while the right valve is less flexuous, with a weaker umbonal ridge and medial sinus; hinge line straight with a (probably narrow) cardinal area; sculpture consists of very fine riblets or threads, fairly regular on the umbonal ridge; the interspaces are generally wider, heavy and irregular on the umbonal ridge and posterior submargins; deep, concentric lines marking resting stages cross the surface of the left valve at fairly regular intervals and these are heaviest on the anterior side; the right valve is generally free from resting marks; the shell is thin so that the internal molds show the form of the valves and the fine radial threads; hinge and cardinal area not exposed.

Length 21 mm.; height 10 mm.; semidiameter 5.5 mm.; (left valve)
Length 23.5 mm.; height 12.5 mm.; semidiameter 4.25 mm.; (right valve)

*Remarks.*— The hinge and cardinal area not being exposed, it is difficult to determine the true relationship of this peculiar species. Its fine sculpture and regularity of form, suggests a *Barbatia,* its strong umbonal ridge, a true Ark. The shell is inequivalve, the umbonal ridge being much higher and sharper on the left valve, and closely resembling the left or arched valve of the Indian *Parallelepipedum* Klein; while on the right valve, the umbonal ridge is comparatively low and weak. Amongst the Barbatias, the species is nearest certain members of the section *Obliquarca* Sacco (type *A. modioliformis* Deshayes), a group well represented in the European Eocene and continuing into the Neogene. In this section, the valves are Modioliform and the umbonal ridge is low and weak.

*Locality and Geologic Occurrence.*— Restin formation, Que. Salado.

### Subgenus DILUVARCA Woodring

### Section ARGINA Gray

**Arca (Argina) samanensis**, n. sp. Plate 1, figs. 4, 5

Shell small, ranging from 20 to 25 mm. in length, moderately convex, subovate to subrhomboidal in outlines; valves equal in size and sculpture, with low, prosogyrate beaks but not prominent umbos; umbonal angle rounded above, with a sloping but not strongly depressed or contracted posterior-dorsal submargins; cardinal area very narrow; the ventral margin is usually slightly contracted just anterior of the umbonal slope; the anterior side slightly rounded, the posterior side nearly straight and forming with the ventral side nearly a right angle; sculpture of both valves nearly alike, with about 24 or 25 low, flattened ribs, divided by flat interspaces of the same width as the ribs themselves; there are about 16 ribs, anterior of the rounded umbonal slope.

Length 21 mm.; height 18 mm.; diameter 14.25 mm.
Length 25.5 mm.; height 22 mm.; diameter 16 mm.

*Remarks.*— This species is commonly associated with *A.* (*Argina*) *sullanensis* Woods in the Upper Saman sandstones of the Chira valley. It differs from the young of that species by its outline which is longer and less circular. The ribs also are fewer in number and the umbos are higher and narrower. The external appearance of *sullanensis* is decidedly *Cardium*-like with strongly convex valves, very numerous ribs (37 or 38) and subcircular outlines.

*Locality and Geologic Occurrence.*— Saman formation, Casa Saman, Lagunitas, Talara.

### Superfamily OSTRACEA Goldfuss
### Family OSTREIDÆ Lamarck
### Genus OSTREA Linnæus

**Ostrea quiroga**, n. sp. Plate 2, figs. 3, 4, 5

Shell medium to large, irregular, higher than long or broadly subovate; surface of both valves smoothish, the lower or attached simply with concentric growth lines; attachment of the left valve often with faint to subobsolete radial costæ or ribs, the upper generally simply with concentric growth lines; attachment of the left valve by the beaks or along the posterior dorsal side, leaving a scar of irregular size; the lower valve is slightly more convex; deeper, irregular and with a high, erect cardinal area carrying a deep, wide ligamental groove; upper or right valve flatter, becoming very massive in large specimens, especially along the posterior dorsal side; cardinal area wide, erect; anterior and posterior submargins of the upper valve feebly dentate.

*Remarks.*— This species is the common oyster in the *Clavilithes* series, replacing the *O. Buski* Woods of the *Turritella* beds. It often grows to a very large size, forming thick oyster zones in the coastal phase sandstones along the foot of the Amotape Mountains from Que. Mogollon and northward. It may be distinguished from the other Peruvian oysters by its nearly smooth surface, only the left valve sometimes showing faint to subobsolete radial ribs or costæ.

*Localities and Geologic Occurrences.*— Salina formation, Negritos, La Brea; Pale Greda formation, Negritos; Parinas formation, Negritos; coastal phase sandstones along the foot of the Amotape; Restin formation, Jabonillal, etc.

**Ostrea restinensis**, s. sp. Plate 2, figs. 1, 2

Shell of medium size, heavy, inequivale; lower or attached valve larger, sometimes irregular but typically subellipitical in form (with the height nearly twice the width), convex and deep; upper valve smaller, flattish and usually quite heavy or massive; sculpture of both valve is similiar, consisting of distant and fairly regular, concentric and overlapping shell layers or lamellæ forming broad smooth bands; on an average specimen, these bands measure about 5 mm. in width; hinge of lower valve with a moderately wide and slightly inclined ligament area; in the upper valve, the hinge area is smaller with the bordering submargins irregularly crenulated.

Height 98 mm.; length 62 mm.; semidiameter 38 mm. (lower valve)
Height 72 mm.; length 46 mm.; semidiameter 35 mm. (lower valve)
Height 79 mm.; length 49 mm.; semidiameter 19 mm. (upper valve)
Height 79 mm.; length 55 mm.; semidiameter 50 mm. (both valves)

*Remarks.*— A coarse, heavy species distinguished by its smooth, concentric banded sculpture. *Ostrea inca* Woods, very common in the basal Salina formation, has a similiar banded sculpture but that species is much smaller and with a comparatively thin shell. The larger individuals of *Ostrea inca,* rarely exceed 55 mm. in length and usually have a pronounced saddle-like form.

*Locality and Geologic Occurrence.*— Restin formation, Restin and Cabo Blanco.

### Order TELEODESMACEA Dall

### Superfamily CARDITACEA Menke

### Family CARDITIDÆ Gill

### Genus VENERICARDIA Lamarck

**Venericardia planicosta, var. labreaensis, n. var.** Plate 3, figs. 1, 2

In this form, the shell is small or medium sized, moderately convex or inflated and with 19 or 20, strong, persistant ribs; umbos prominent, with strongly curved, adjacent beaks; lunule cordate, moderate in size and deeply sunken; on the umbos, the ribs are high, narrow and knife-like with deep, wide and flat interspaces; ventrally the ribs become wider and on the medial portion of the valve are broad and flat-topped, with the interspaces remaining deep but only about one-half the width of the ribs themselves; the first five anterior ribs are tri-partite with a central, larger, riblet bordered on each side by a smaller riblet; on the next three or four ribs (8-9), the central riblet increases rapidly in size, becoming wide and flat, while the lateral riblet is very small and threadlike, or simply a low, vanishing terrace; the following five ribs (to 14) lie across the medial portion of the valve to the umbonal ridge; the remaining ribs (to 19 or 20) on the posterior-dorsal submargins are low, narrow with wide interspaces.

Length 36.50 mm.; height 34 mm.; diameter 27 mm.

*Remarks.*— This variety is the dominant form in the Negritos formation or the Turritella beds of La Brea. It is distinguished from the other members of the *planicosta* group, by its constantly tripartite anterior ribs. It is always a small or medium-sized shell, our largest specimen being about 45 mm. in length.

*Locality and Geologic Occurrence.*— Negritos formation, La Brea.

**Venericardia talara**, n. sp. Plate 3, figs. 4, 5

Shell subcircular, inflated with full, prominent umbos; beaks small, adjacent, curved over the deeply sunken lunule and placed as illustrated quite close to the anterior side; ligamental area showing a deep, but narrowly, lenticular slit along the hinge-margin; general outline of shell is subcircular to nearly square, the height being about equal to the length; sculpture of 24 to 25 narrow, strongly beaded or roughened ribs and deep, groove-like interspaces; the ribs are very narrow and sharp on the posterior-dorsal submargins, generally wider and rougher on the anterior side; umbonal slope feeble, bordered by a depressed or concave zone.

Length 31 mm.; height 31.5 mm.; semidiameter 11 mm. (type, right valve)
Length 42 mm.; height 38 mm. (broken)

*Remarks.*— This species is related to *Venericardia rotunda* Lea from the Claiborne and Jackson Eocene of the Southern States, the nearest approach being the shell figured by Harris[1] on plate 28, as figure 7. *Rotunda* is usually much smaller, less convex and the post-umbonal area is less deeply impressed. The sculpturing of the narrow ribs of *talara* is more elaborate. This species is known only from the fossil zone at the base of the Restin.

*Locality and Geologic Occurrence.*— Restin formation, Negritos.

### Superfamily LUCINACEA Anton

### Family LUCINIDÆ Fleming

### Genus LUCINA Lamarck

**Lucina corbula**, n. sp. Plate 1, fig. 7

Shell of medium size, thin, orbicular and strongly inflated;

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[1] Harris, 1919, Bull. Amer. Pal., vol. 6, p. 78, pl. 28, fig. 7.

beaks low, slightly prosogyrate and situated about the anterior one-fourth; the posterior and anterior margins, together with the ventral margin are evenly rounded and form part of the same circle; the posterior-dorsal margin is straight, meeting the posterior side in a broad curve; the anterior dorsal margin is relatively short and descending; the shell is strongly convex or inflated, greatest about the center; surface smoothish or simply sculptured with rough but fairly strong, irregular growth lines; the interior of the shell, judging by the internal mold is more or less roughened or pustulose in the center and umbonal area; the pallial line situated close to the ventral margin is irregular with short radiating lines or furrows crossing it; hinge and lunular characters not visible in our specimen.

Length 34.5 mm.; height 30.5 mm.; semidiameter 9 mm.

*Remarks.*— In general form, this shell closely resembles the *Lucina corpulenta* Dall from the Chipola Miocene of Florida, the Peruvian species being less equilateral. From rocks of Eocene age, the shell may also be compared with the *Lucina subvexa* Conrad and *Lucina ozarkana* Harris of the Wilcox and St. Maurice beds of the Southern States. From both of these species, the present form differs in its shorter, less produced and rounder anterior side.

*Locality and Geologic Occurrence.*— Restin formation, Que. Conventos.

### Genus PHACOIDES Blainville

### Subgenus MILTHA H. and A. Adams

**Phacoides (Miltha) conventus**, n. sp. Plate 3, fig. 3

Shell of medium size, suborbicular, compressed or slightly convex; beaks small and inconspicuous, with scarcely differentiated umbos; ventral and anterior margins of the shell evenly rounded; dorsal and posterior margins nearly straight, meeting to form a right angle; the posterior area is rather wide, and defined in the left valve by a faint fold along the umbonal slope; sculpture consists of fine, fairly regular raised concentric lines or lamellations betweens wider concentric bands or interspaces; these concentric lamellations continue across the dorsal area to the hinge margins; the interspaces or bands are finely sculptured with small, raised growth lines or threads; interior concealed.

Length 29 mm.; height 26 mm.; semidiameter 4 mm.

*Remarks.*— This species is closely related to *P.* (*Miltha*) *claibornensis* Conrad from the St. Maurice Eocene of Alabama, Georgia and Virginia. In Dall's[2] and Harris's[3] figures of a right valve, the umbos are shown as more central and with a fairly large lunule, but no such structure is noticeable on our specimen which is a left valve.

*Locailty and Geologic Occurrence.*— Restin formation, Que Conventus.

### Family DIPLODONTIDÆ Dall

### Genus DIPLODONTA Bronn

**Diplodonta caboblanca**, n. sp. Plate 1, figs. 6, 8

Shell small or medium size, thin, moderately inflated, subcircular to subovate in form; valves inequilateral with small, closely adjacent beaks and wide, full but not prominent umbos; greatest inflation of the valves slightly posterior of the middle, along an evident bulge extending from the umbos to the posterior-dorsal submargins; the posterior-dorsal submargins more or less impressed in a *Lucina*-like fashion but less evident on some shells than others; no lunule; surface simply marked with irregular growth lines; interior concealed.

Length 26 mm.; height 24 mm.; diameter 14 mm.; (Holotype, Cabo Blanco)
Length 32 mm.; height 29 mm.; diameter 17 mm.; Cabo Blanco
Length 23 mm.; height 22 mm.; diameter 14 mm.; Restin

*Remarks.*— The specimens from the Cabo Blanco sandstones of Parinas age are somewhat larger than those from the Restin, as indicated by the above measurements. The hinge poorly preserved in a few specimens, has a bifid posterior cardinal tooth in the right valve and apparently no laterals. Most of the fossils show a slightly impressed posterior dorsal area but not differentiated as amongst the *Lucinidæ.*

*Locality and Geologic Occurrence.*— Parinas formation, Cabo Blanco. Restin formation, Restin and Cabo Blanco.

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[2] Dall, W. H., 1903, Trans. Wagner Free Inst., vol. 3, pt. 6, p. 1374, pl. 50, fig. 18.

[3] Harris, G. D., 1919, Bull. Amer. Pal., vol. 6, p. 121, pl. 39, figs. 8, 9.

### Superfamily CARDIACEA Lamarck

### Family CARDIIDÆ Fischer

### Genus CARDIUM Linnæus

### Subgenus CERASTODERMA Mörch

**Cardium (Cerastoderma) himertum**, n. sp. Plate 3, fig. 6

Shell small, plump, slightly inequilateral and oblique; greatest convexity of the valves about the middle, with scarcely differentiated umbos ending in the small, pointed beaks; valves sculptured with 22 or 23, strong, rounded ribs, separated by narrower flattened interspaces; the ribs are of about equal size, except those near the anterior and posterior extremities; the interspaces are nearly smooth, often with an interstitial thread except on the anterior side where they are cross-striated by concentric raised threads; this cross-striation is particularly well-marked on the sides of the interspaces and margins of the ribs, their summits however being smooth; internally, the ribs show as narrow, rounded grooves with wide, flat interspaces; these costal grooves extend well up towards the umbos which are smooth.

Length 20.5 mm.; height 20 mm.; semidiameter 6.5 mm.

*Remarks.*— This species resembles the *C. panastrum* Dall[4] of the Oak Grove sands of Florida, but differs as far as can be determined from figures, by its more numerous and narrower ribs. Both species are oblique, which gives to these shells, the external aspect of a small, plump *Venericardia.*

*Locality and Geologic Occurrence.*— Restin formation, Que. Salado.

### Class GASTROPODA

### Subclass STREPTONEURA Spengel

### Order ASPIDOBRANCHIA Schweigger

### Suborder RHIPIDOGLOSSA Troschel

### Family NERITIDÆ Lamarck

### Genus NERITINA Lamarck

**Neritina stadnichenkiæ**, n. sp. Plate 4, figs. 7, 8

Shell small to fairly large, transversely-ovate, the form of the shell being depressed and *Velates*-like; spire very small, flattened, lying in the same plane as the upper surface of the body-whorl; last whorl is large, nearly hiding the earlier turns and most of the spire, it is transversely ovate in form, vaulted or convex across the back, strongly flattened above; aperture large, with a slightly flaring and sinuous edge; inner lip with a wide callous platform spreading over most of the ventral surface of the body whorl; colummella not exposed; surface smoothish or simply marked with faint spirals and growth lines.

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[4] Dall, W. H., 1900, Trans. Wagner Free Inst., vol. 3, pt. 5, p. 1093, pl. 40, fig. 14.

See also Gardner, J., 1926, Prof. Paper 142-C, U. S. Geol. Survey, p. 137, pl. 23, fig. 5.

Length or greater diameter 23.5 mm.; height 18.25 mm.; lesser diameter 11.5 mm. (Holotype)

*Remarks.*— The Holotype is a small, but nearly perfect specimen with a length of about 24 mm. When full-grown, the shells become much larger, massive and judging from a fragmentary specimen may reach nearly 40 mm. in length. In form, the species closely approaches the well known *Velates Schmiedeli* Chemn., but probably never attains the large size of that shell. Compared with *Velates* of the same size, it is seen that the beaks are constantly terminal and marginal, while even in quite young *Velates,* the beaks are separated from the margins by a rather wide space, mainly due to a great thickening of the ventral face of the body-whorl. This species is named for Miss Maria Stadnik Stadnichenko, Micro-Paleontologist at Negritos.

*Locality and Geologic Occurrence.*— Restin formation, Que. Salado.

### Order CTENOBRANCHIATA Schweigger

### Superfamily GYMNOGLOSSA Gray

### Family PSEUDOMELANIIDÆ Fischer

### Genus BOGGSIA, n. gen.

**Type.- Turritella anceps** Woods

*Turritella anceps* Woods, 1922, in Bosworth's Geology of North West Peru, p. 81, pl. 8, figs. 12, 13, pl. 9, figs. 1, 2.

The following is a description of the genus *Boggsia.*

Shell melanoid to sub-turritelloid, subulate, with numerous, convex to subangulated whorls; sutures distinct, strongly oblique or descending; early whorls smooth or finely sculptured with revolving spirals; later whorls smooth; growth lines oblique but not sinuous; aperture subovate, *Littorina*-like in shape and with a thin outer lip.

*Remarks.*— Among the more characteristic fossils of the Middle Eocene or Clavilithes series, are two melanoid gastropods described by Woods as *Turritella anceps* and *annectans.* In referring these species to the *Turritellidæ,* Woods relied principally on the features of the early whorls which are rounded or convex in form and often sculptured with strong spirals. With growth the whorls may become angulated (*annectans*), or remain simply rounded (*anceps*), the sutures strongly descending and the spirals obsolete or absent so that the surface of the adult shell is smooth or nearly so. The growth lines are oblique to the vertical axis of the shell, but not sinuous as in true *Turritella* and *Mesalia.* The shape of the aperture is subovate and *Littorina*-like.

The angulation of the whorl is a variable character, reaching its maximum in half-grown shells of *annectans.* With continued growth, this angulation generally disappears and the profile of the whorl becomes rounded or even convex. In *anceps,* the angulation is very feeble, the form is more elongate and the shell resembles an overgrown *Melanella* (*Eulima*).

When full-grown, both *anceps* and *annectans* have a decided *Melania*-like aspect and I am inclined to regard them as members of Fischer's *Pseudomelaniidæ,* but apparently distinct from any of the known generic forms. In shape, *Boggsia* approaches the more elongate species of *Pseudomelania* and *Bayania,* but differs by its strongly oblique aperture. With the fresh-water Melanias, *Boggsia,* according to Cossmann's classification and description, would fall near the section *Stenomelania* Fischer, but differs both in its marine habit and non-sinuated outer lip.

This new genus is named for Mr. O. D. Boggs, resident geologist at Negritos.

### Superfamily TÆNIOGLOSSA Bouvier

### Family TURRITELLIDÆ Gray

### Genus MESALIA Gray

### Subgenus WOODSALIA, n. subgenus

**Type.- Turritella negritosensis** Woods Plate 4, figs. 5, 6

The following is a description of the subgenus *Woodsalia.*

Shell short, stubby and solid; whorls comparatively few, rapidly enlarging so that the taper of the spire is rapid and *Mesalia*-like; whorls convex, often with a strong peripheral carina or with one or more strong, spiral cords; base of last whorl rounded or convex, not flattened as in *Turritella;* growth lines sinuated, *Mesalia*-like, but the basal lobe projecting but little beyond or in front of the upper or sutural lobe; aperture rounded, with a shallow anterior sinus; inner lip thickened, its edge free so that the peristome is continuous and entire; a strong, oblique, parietal fold often present.

*Remarks.*— Woods considered *negritosensis* as a true *Turritella,* allied to *T. mortoni* Conrad, a Wilcox species of the southern United States, belonging to Montfort's subgenus *Haustator.* From most species of *Turritella, negritosensis* differs by its shorter, stubbier form, less numerous whorls but principally by its continuous peristome and shallow anterior sinus. In most of these characters, *negritosensis* is obviously more closely related to *Mesalia* than to the true Turritellas.

In full-grown individuals, the last whorl appears to be slightly smaller and contracted. The outer lip has a wide, medial sinus and a convex fold at its anterior portion. *Mesalia* has a similiar sinus but the lower or anterior fold projects much further forward than in this species. There is a shallow, *Mesalia*-like anterior canal at the tip of the pillar or columella. The inner lip is thickened or callused, its edge free so that the peristome is entire and continuous in mature specimens. A strong parietal fold may be present but this feature is not constant and does not appear in many specimens.

In *Turritella lissoni* Woods, the aperture is less commonly preserved but judging from fragmentary specimens, it appears to agree with *negritosensis* in essential characters. The species frequently has a strong basal cord which lies submerged in the sutures of the earlier turns. The *Turritella* (?) *robusta* Gabb from the Cretaceous "Chico Groups" of California, judging by Stewart's[5] figure, resembles *negritosensis* by its short, stubby whorls, sculpture and large apical angle. It may belong to this subgenus.

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[5] Stewart, 1926, Proc. Acad. Nat. Sci. Phila., vol. 78, p. 353, pl. 21, fig. 4.

*Locality and Occurrence.*— Negritos formation, Negritos and La Brea.

### Family CERITHIIDÆ Menke

### Superfamily CERITHINÆ H. and A. Adams

### Genus CERITHIUM Bruguiere

### Subgenus IDDINGSIA, n. subgenus

**Type.- Cerithium læviusculum** Gabb Plate 4, figs. 1, 4

*Cerithium laeviusculum* Gabb, 1869, Amer. Journ. Conch., vol. 5, p. 27., 1877, Journ. Acad. Nat. Sci. Phila., vol. 8, p. 264, pl. 35, fig. 4.
*Cerithium paytense* Woods, 1922, p. 87, pl. 10, figs. 7-9.
*Faunus paytense* Hanna and Israelsky, 1925, Proc. Calif. Acad. of Sci., 4th series, vol. 14, p. 42, pl. 8, fig. 8.

The following is a description of the subgenus *Iddingsia.* Shell large or medium size, elongate, smooth except the nepionic whorls which have a cancellate sculpture of both ribs and spirals; immature shells have a flattened base with strong, spiral grooves and cords; when full-grown, the base is rounded, smooth or with irregular spiral bands; outer lip thin, moderately expanded in front, with a wide, shallow posterior sinus a short distance below the suture; anterior canal short, erect, deep and slightly recurved; growth lines sinuous, parallel to the contour of the outer lip, on the spire whorls showing a wide, concave sinus between the sutures; heavy, rib-like resting marks developed on the ventral surface of the body whorl of large individuals; inner lip callused, no columellar or parietal plaits.

*Remarks.*— *Cerithium læviusculum,* the type of this new subgenus, was described by Gabb from specimens collected by Professor Orton from the Saman sandstones of Paita. Later the same species was redescribed by Woods from the same locality as *Cerithium paytense.* Owing to the strong callosity of the inner lip, Hanna and Israelsky removed the species from *Cerithium* and referred it to *Faunus,* but the discovery of more perfect specimens definitely show, that this species should be retained in the family *Cerithiidæ.*

*Iddingsia* bears much resemblance in form and in its smooth whorls to *Gymnocerithium* Cossman of the European Portlandian, but differs in possessing a typical cerithioid anterior canal and the outer lip is sinuous and not straight. Specimens with perfect outer lip and anterior canal are very rare, and the above diagnosis is partly based on a well preserved specimen of var. *saladoensis* from the Upper Restin. The nepionic whorls have a cancellated sculpture of ribs and spirals, this sculpture generally persisting somewhat longer on typical *læviusculum* of the Upper Saman, than in the shells from the older beds. The succeeding whorls are smooth, flat-sided or slightly convex between close, distinct, linear sutures. Immature shells have a flattened base and a more or less angulated periphery, the base becoming well rounded when adult. Due to the slightly expanded outer lip, resting marks may be developed at intervals on certain large, gerontic individuals.

This new subgenus is quite abundant and characteristic of the Peruvian Upper Eocene but rare or lacking in the Oligocene. Its earliest appearance is in the Upper Restin, of La Breita and Que. Salado as variety *saladoensis,* where it occurs associated with *Corubla* (*Cuspicorbula*) *busera* and *Anomia septenaria.*

This new subgenus is named for Mr. Arthur Iddings, Assistant Manager at Negritos and formerly in charge of the Geologic Office.

**Cerithium læviusculum, var. saladoense, n. var.** Plate 4, figs. 2, 3

This variety differs principally from typical *læviusculum* in its more accelerated development. It is usually a smaller shell, the whorls slightly more convex, sometimes appearing coronate or feebly shouldering about the upper suture, and the base of the whorl is more rounded in immature shells and with stronger, persistant sculpturing. In a similiar degree, the cancellated sculpture of the early whorls is of shorter duration and confined to fewer whorls.

*Locality and Geologic Occurrence.*— Restin formation, Que. Salado, La Breita.

### Subgenus PERUCERITHIUM, n. subg.

**Type.- Cerithium (Perucerithium) restinense**, n. sp.

The following is a description of the subgenus *Perucerithium*:

Shell large, heavy, solid; whorls numerous between close, linear or deeply channelled sutures; surface smooth, or with heavy longitudinal ribs or folds, the base flattened or convex, and generally with spiral sculpture; outer lip thin, sinuous, slightly expanded about the basal portion; there is a wide, shallow, posterior sinus, its axis about the middle of the whorls and midway between the sutures; anterior canal short, apparently with a typical, recurved cerithial canal; growth-lines sinuous, following the contour of the outer lip.

*Remarks.*— The older Peruvian Eocene is characterized by several large cerithioid fossils such as *Pseudoglauconia lissoni* Douvillé and several species, belonging to this new subgenus. To *Perucerithium* belong besides the type species *restinense*, the *"Cerithium" negritosense* Woods, *hopkinsi, xenium* and *iddingsi* Olsson.

In most cases, the outer lip being very thin and fragile, has been destroyed during fossilization. When preserved, it is seen to be feebly expanded about the anterior portion and with a wide, shallow posterior sinus. The growth lines closely parallel the contours of the lip, and show a wide sinus midway between the sutures, a forward fold across the base and a small sinus about the end of the cerithial anterior canal. In *Pseudoglauconia,* the growth lines are similar but also have a deep, *Glauconia*-like sinus about the center of the base.

The large cerithioids of the European Eocene superfically resemble *Perucerithium,* but differ in several, important respects. In *Campanile,* the outer lip is broadly expanded and the columella provided with one or more heavy folds. *Bellardia* is somewhat closer, but has a different shaped aperture, the outer lip being strongly recurrent at the suture besides possessing parietal plaits and strong, knobs or humps on the dorsal side of the penultimate whorl.

**Cerithium (Perucerithium) restinense**, n. sp. Plate 5, figs. 1, 2, 3, 4, 7

Shell rather large, solid, subelongate; whorls numerous, the earlier ones straight or slightly convex in profile, the later coronated or developing a sharp, reflexed edge about the upper suture; sutures at first simple, becoming canaliculate on the lower half of the shell; general surface of the shell is smooth, except for spirals on the base of the last whorl and broad low ribs of variable character on the upper turns; these ribs number 6 or 7, are narrow, straight or a little oblique, more or less in line across the sutures, and separated by wide, shallow interspaces; the ribs are generally absent from the last and penultimate whorls or even earlier; base rounded or subcontracted, with coarse, spiral cords; growth-lines sinuous, with a wide, shallow sinus midway between the sutures and a slight forward basal fold; outer lip thin, somewhat expanded, a weak posterior sinus or inflexion across the upper one-quarter and a broad, convex basal fold; anterior canal, cerithioid, short and recurved.

Length 70 mm. (2 whorls); greater diameter 56 mm.
Length 88 mm. (4½ whorls); greater diameter 40 mm.

*Locality and Geologic Occurrence.*— Parinas formation, Cabo Blanco sandstones near Restin.

### Genus RHINOCLAVIS Swainson

### Subgenus HOPKINSIANA, n. subg.

**Type.- Morgana costata** Woods Plate 6, figs. 8, 10, 11

The following is a description of the subgenus *Hopkinsiana.*

Shell small or medium size, cerithioid to pupoid in form; whorls flat or slightly convex, often weakly coronated about the upper suture; protoconch unknown; early nepionic whorls cancellated or sculptured with both ribs and spirals, later whorls with strong spiral bands or simply smooth; base sloping; aperture like *Rhinoclavis* but with a sinuated outer lip; anterior canal cerithioid, strongly oblique and recurved; apparently no parietal or columellar plaits; outer lip thin with a broad shallow sinus.

*Remarks.*— Woods referred his *costata*[6] and *magma*[7] to the

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[6] Woods, H., 1922, in Bosworth's Geology of North-West Peru, p. 82.
[7] *Ibid.* p. 83.

Indian and Persian genus *Morgana* Cossmann of the *Melanopsidæ* The smaller *costata* is without much doubt, a cerithioid, perfect specimens having a typical cerithioid siphonal canal and a quite typical *Cerithium* aperture. The anterior canal is strongly oblique with a relatively short columellar pillar as in *Rhinoclavis,* which the fossils also resemble in form. They differ mainly from *Rhinoclavis* by their sinuated outer lip and absence of columellar and parietal plaits. Typical *Rhinoclavis* does not appear to be known as fossil, the Tertiary species of Europe, being referred by Cossmann to the subgenera *Pseudovertagus* Vignal and *Semivertagus* Cossmann. *Hopkinsiana* is closest to *Semivertagus* in lacking both parietal and columellar plaits but is distinguished by its sinuated lip.

### Subfamily POTAMIDINÆ H. and A. Adams

### Genus LAGUNITUS, n. gen.

**Type.- Telescopium peruvianum Woods**

*Telescopium peruvianum* Woods, 1922, in Bosworth's Geology of North-West Peru, p. 91, pl. 11, figs. 13, 14.

The following is a description of the genus *Lagunitus.*

Shell conic to broadly turritelloid, consisting of numerous, narrow whorls between close, linear sutures; whorls flattened, sculptured with numerous, straight or concave folds, generally crossing from suture to suture, but not extending below the peripheral groove onto the base; the periphery of the base is angular, with a deep furrow lying between two spiral cords emerging from the suture; base flattened, generally covered by callus deposit spreading from the inner lip; the growth lines have a strong forward curve on the flattened base and a weak or shallow sinus across the main face of the whorl, midway between the sutures; perfect aperture not known, but from fragmentary specimens the outer lip appears to have been more or less expanded; inner lip heavily callused at its posterior side or junction with the outer lip, spreading upward across the face of the next whorl to and sometimes beyond the upper suture; outer lip not known; a short, stout, twisted columellar pillar and anterior canal.

*Remarks.*— Two species of this peculiar and interesting group are known from the Upper Saman rocks of Peru. They are quite common in some localities (Lagunitas), but since they occur principally in coarse, gritty sandstones, the shells are invariably broken and no specimen with a complete aperture has been found. The flattening of the base is accentuated by the breaking and loss of the later whorls.

*Lagunitus* is clearly a member of the *Potamidinæ,* and *peruvianam,* the most abundant species, was provisionally referred to the genus *Telescopium* by Woods. *Lagunitus* differs from *Telescopium* represented in the Peruvian Eocene by a typical species in the Parinas sandstones, by its larger shell with a dominantly axial and not spiral sculpture, and by its heavily callused inner lip. Details of the outer lip, columellar and anterior canal are not sufficiently well-known for comparison.

The two known species of this genus, *peruvianum* Woods and *samanense* Olsson appear to be limited to the Upper Eocene or Saman formation.

### Genus HARRISIANELLA, n. gen.

**Type.- Harrisianella peruviana, n. sp.**

Shell turritelloid, with a gradual tapering spire and suture bordered by a *Terebra*-like fasciole; base of last whorl flattened, angled and bordered by a peripheral cord between 2, deep spiral grooves; sculpture of closely spaced, curved riblets which begin abruptly at the peripheral cord and extend to the upper suture; base with only revolving cords; aperture rounded, the outer lip sinuous, with a broad medial sinus and a forward convex curve across the basal portion; peristome probably entire, the beak or pillar with an encircling fold.

*Remarks.*— Because of their strong, sutural fasciole and axial sculpture, these shells bear a striking but superficial resemblance to the Terebras, and a species evidently belonging to this genus, was described by Heilprin[8], as *Terebra plicifera* from the Texas Eocene. The peristome is entire, the outer lip with a wide, medial sinus and a convex fold or bulge across the basal portion. The base of the aperture being destroyed, the absence or presence of a shallow canal cannot be determined.

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[8] Heilprin, 1880, Proc. U. S. Nat. Mus., p. 151, pl., fig. 8., also Aldrich, 1897, Bull. Amer. Pal., vol. 2, No. 8, p. 170, pl. 3, fig. 2a.

The genus *Aurelianella* Cossmann[9], the type which is *A. mutabilis* Cossmann from the Parisien Eocene, resembles *Harrisianella* in form and sculpture, but is a smaller shell, the outer lip is not sinuous, and the axial sculpture is lacking from the later whorls.

*Harrisianella* probably belongs to the *Potamidinæ.* It is named for Professor G. D. Harris, of the Paleontological Department of Cornell University.

**Harrisianella peruviana, n. sp.** Plate 8, fig. 7

Shell of medium size, turritelloid, with numerous, slowly tapering whorls; sutures indistinct, lying in a deep groove and carrying a small, central cord; whorls flat or straight sided and sculptured in a *Terebra*-like fashion with a strong sutural fasciole and axial ribs, the upper ends of which are disjointed by the fasciole groove; below the fasciole, the surface has about 24, straight to slightly curved, strong riblets, which end, either at the lower suture or very abruptly at a spiral cord, between two grooves encircling the periphery of the body whorl or the upper edge of the base; base is flattened or slightly excavated and carrying 4 or 5, subobsolete, spiral cords; aperture rounded, the peristome probably entire.

Length 25.5 mm. (6 whorls); diameter 9.5 mm.

*Locality and Geologic Occurrence.*— Restin formation, Que. Salado, Saman formation, Caleto Sal.

### Family CERITHIOPSIDÆ H. and A. Adams

### Genus CERITHIOPSIS Forbes and Hanley

**Cerithiopsis quemada, n. sp.** Plate 6, fig. 9

Shell small, slender, with numerous whorls and sculpture of spiral cords and fainter ribs; protoconch unknown; spire whorls preserved nearly 5, flattened between distinct sutures; base of last whorl slightly sloping, convex, but not contracted; sculpture of early whorls consists of 4 spiral cords, nodulated by narrow, straight riblets, separated by narrow, deep intervals; the riblets are straight, pass from suture to suture, and weakly across the spiral intervals; in addition, there is a faint cord showing in the suture; on the last whorl, the spirals increase to about 11, only the upper 4 (the 5th slightly) being nodulated by the riblets, the others covering the base being nearly smooth; there are about 27 riblets on the last whorl, but they are much weaker than those of the earlier turns; columella straight; outer lip broken.

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[9] Cossmann, 1893, Catal. ill. coq. foss. Eoc. env. Paris, App. 1, p. 10, fig. 10., also Cossmann and Pissarro, Icon. complete des coq. foss. de l'Eocene env. Paris, tome 2, pl. 26, figs. 139, bis-1.

Length 9 mm.; diameter 3 mm.

*Remarks.*— This species is referred with much doubt to the genus *Cerithiopsis.* It differs from most species of that genus, by the larger size and less contracted base. In all our specimens, the aperture is broken and the early spire whorls are lost.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

### Family DIASTOMIDÆ Cossmann

### Genus DIASTOMA Deshayes

**Diastoma geositta, n. sp.** Plate 6, figs. 1, 2

Shell cerithioid, stout, rugose; spire long, nearly twice the length of the aperture and composed of 7, 8 or more flat-sided whorls; protoconch unknown, sutures grooved and with a central, spiral cord; sculpture subcancellate, with strong, regular ribs and spirals; the ribs numbering about 12 on the penultimate and 13 on the last whorl, are strong, regular, longitudinal folds and divided by interspaces of the same width as the ribs themselves; on the spire-whorls, the ribs extend from suture to suture and are nearly in line; on the body-whorl they end abruptly at the periphery; spirals are heavy, regular cords and number about 5 (not including the sutural cord) on the spire-whorls and above the periphery of the body-whorl; base sculptured with numerous, irregular spiral cords, base flattened, sloping: aperture broadly elliptical, the inner lip strongly callused, the columella excavated; outer lip broken.

Height 39 mm.; diameter 17 mm.; aperture 14 mm.

*Remarks.*— This and the next two species are tentatively referred to the genus *Diastoma,* principally on their sculpture pattern and may require change as more perfect material is discovered. In true *Diastoma*, the peristome is continuous without a true cerithioid anterior canal, while in these shells, the aperture although broken, appears cerithioid, with a fairly long, excavated columella, resembling the incomplete apertures of certain *Ptychocerithium.*

*Locality and Geologic Occurrence.*— Parinas formation, Keswick Hills.

**Diastoma furnaria**, n. sp. Plate 6, fig. 3

Shell similar to the preceding species in form but with a finer sculpture; sutures grooved or slightly excavated; whorls flat sided, feebly contracted about the middle of the body whorl and more or less coronated below the upper suture; last whorl angulated about the middle with a sloping base, ending in a nearly straight, anterior canal; early spire whorls unknown; sculpture of a feeble series of axial ribs or folds (which probably were continuous from suture to suture on the earlier spire whorls) about the upper suture, extending in a subobsolete manner to the periphery of the last whorl; the main sculpture consists of fine, subregular, spiral bands which cover the whole surface from the upper suture to the tip of the anterior canal; aperture subelliptical to subtriangular, the inner lip slightly callused and angulated at its anterior and posterior ends; columella excavated; outer lip broken.

Length 33 mm. (2 whorls); diameter 18 mm; aperture 19 mm.

*Remarks.*— Differs from *geositta* by its plainer sculpture, the ribs at maturity being confined to a low, coronated band in front of the upper suture.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

**Diastoma elænia**, n. sp. Plate 6, figs. 4, 5, 6, 7

Shell small, with strongly coronated whorls and a sculpture of ribs and spiral bands; spire long, nearly twice the length of the aperture and composed of 5+ whorls; protoconch unknown, the first 4 or 5 post-nuclear whorls are straight or slightly convex in profile and ornamented with numerous, straight riblets, crossed by 5 or 6, revolving bands between distinct, incised lines; these spiral bands are nearly equal in size, except the uppermost which is constantly a little heavier and on the succeeding turns contributes to the formation of a coronated zone about the upper edge of the whorl; later turns strongly coronated, the penultimate and body whorl with about 10, straight, strong ribs between wider interspaces; the ribs end abruptly at a strong, peripheral cord which is immersed in the sutures of the earlier whorls, the upper ends of the ribs are strongly knobbed in some specimens; whole surface overrun by spiral bands, which are wider on the upper half of the whorl, finer and more crowded on the base; aperture elliptical to subtriangular; inner lip callused, the columellar area excavated; outer lip broken.

Height 20 mm.; (broken); diameter 9.5 mm.; aperture 9.5 mm.

*Remarks.*— This is a small species and may possibly be only a variety of *furnaria.* Our specimens are evidently mature and show a marked change in sculpture from their nepionic to adult whorls.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

### Family STROMBIDÆ d'Orbigny

### Genus STROMBUS Linnæus

**Strombus burhinus,** n. sp. Plate 5, figs. 5, 6

Shell of moderate size, biconic, with a fairly high spire and a long, narrow aperture more than one-half the length of the shell; whorls 3 (tip broken) between deep and slightly excavated sutures; spire whorls slightly concave or contracted about the middle between two, faint revolving ridges; body whorl large, at first faintly angulated about the middle by the lower ridge, later becoming sharply shouldered by the upper ridge; on still larger specimens, the shoulder becomes even more prominent and sometimes nodose, while the lower ridge becomes simply a cord or disappears; base of last whorl straight and Cone-like; aperture narrow, linear, the outer lip in all our specimens being thin and straight, paralleled by the growth lines; inner lip slightly callused.

Length or height 54 mm.; (broken); diameter 30 mm.; aperture 40 mm.
Length or height 59 mm.; (estimated)

*Remarks.*— The generic affinities of this species with the *Strombidæ* is uncertain. In form, the shell resembles an immature *Strombus,* this appearance being further accentuated by the development of a strongly angled shoulder which becomes even nodose on old individuals. In other features the species approaches *Clavilithes,* but the base is not contracted, being straight and Cone-like. The outer lip is thin and straight in all our specimens and appears to be mature.

*Locality and Geologic Occurrence.*— Restin formation, Basal Restin of Negritos, Pozo valley. Restin and Cabo Blanco.

### Superfamily RACHIGLOSSA Gray

### Family FASCIOLARIIDÆ Chenu

### Genus PERUFICUS, n. gen.

**Type.- Peruficus lagunitensis**, n. sp.

The following is a description of the genus *Peruficus.*

Shell pyriform with an inflated body whorl and a low to moderately elevated spire; base of body whorl usually contracted and with a long, straight fusoid anterior canal; surface sculpture reticulate, persistant and heaviest on the spire whorls; columella with two (or possibly three) strong, sharp plaits.

*Remarks.*— This name is proposed for a group of two or three species, resembling *Ficus* in form and sculpture, the *Fusidæ* in their thin, inflated body whorl and straight anterior canal and the *Turbinellidæ* in possessing true columellar plaits. The group is probably related to *Strepsidura* Swainson and to *Glyptostyla* Dall, the type of which last, is a Miocene species from Panama, but both these genera differ by their curved or twisted anterior canal. The Eocene genus *Mazzalina* of Conrad, is pyruliform, with a comparatively long but twisted anterior canal and the columellar provided simply with auxiliary folds, there being several (5 or 6 in *inaurata* Conrad) very weak, oblique plaits. *Whitneya* Gabb, according to Stewart[10], is a synonym of *Strepsidura.*

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[10] Stewart, R. B., Gabb's California Fossil Type Gastropods, Proc. Acad. Nat. Sci. Phila., vol. 78, p. 404.

**Peruficus lagunitensis, n. sp.** Plate 8, fig. 11

Shell small, pyriform, coarsely sculptured with revolving spirals and straight, nearly equal riblets; body whorl large, inflated, with a low, elevated spire about one-fifth the total length of the shell; whorls about 4, with appressed, indistinct sutures; body whorl large, convex and deeply contracted about the base, a coarsely reticulate sculpture of strong, revolving, spiral cords and straight, nearly equal riblets; sutures bordered on the lower side by two, closely adjacent cords and these in turn by a depressed or concave zone; the spirals usually consist of two kinds, a primary set of heavy cords, with a finer, secondary spiral in each interspace; the riblets are straight, about equal to the spirals in strength, which they cross and nodulate, the resulting sculpture being coarsely reticulate and *Pyrula*-like; former resting stages indicated by somewhat heavier, longitudinal ridges, roughly spaced 120 degrees apart; aperture broadly semi-lunar, narrowly produced in the region of the anterior canal; anterior canal long, straight and narrowed in a *Fusus*-like manner; columella with 2 (possibly 3) folds.

Height 21 mm.; diameter 14.5 mm.; aperture 17 mm.

*Locality and Geologic Occurrence.*— Saman formation, Lagunitas.

### Family FUSIDÆ Tryon

### Genus LEVIFUSUS Conrad

**Levifusus mallacus, n. sp.** Plate 7, figs. 1, 2

Shell of medium size, *Fulgur*-like in form and sculpture; whorls 4 or more, widely shouldered above, the shoulder angle bearing 6, strong, heavy spines or tubercles, rest of the surface is smooth except for growth lines and fine, alternating siprals on the anterior canal; growth lines straight except as they cross the shoulder angle when they may be drawn into the spines; aperture broadly ovate but narrowed or produced in front; anterior canal moderately long, strongly bent or twisted near the tip; outer lip thin, the inner lip more or less callused along the face of the body-whorl.

Height 63 mm.; diameter 49 mm.; (Que. Salado)
Height 42 mm.; (broken); diameter 35 mm.; (Lagunitas)

*Remarks.*— This species is provisionally referred to *Levifusus* Conrad, principally from its resemblance to *Levifusus branneri* Harris of the Jackson Eocene of Mississippi and Texas. The Peruvian fossil is still more *Fulgur*-like and the base is entirely smooth, lacking the encircling spiral which in true *Levifusus* emerges from the suture of the upper side of the aperture. With the East Coast Fulgurs, the resemblance is also quite striking, especially to the more spinous species as *Fulgur echinatum* Dall of the Caloosahatchie Pliocene, but the anterior canal appears to be shorter and more twisted.

*Locality and Geologic Occurrence.*— Restin formation, Que. Salado; Saman formation, Lagunitas (Saman conglomerate).

### Superfamily TOXOGLOSSA Troschel

### Family CANCELLARIIDÆ Adams

### Genus ADMETE Kroyer

### Subgenus ADMETE Kroyer

### Section BONELLITIA Jousseaume

**Admete (Bonellitia) luffa**, n. sp. Plate 8, figs. 3, 4

Shell small, delicate, with a fairly high spire and coarsely reticulate sculpture; protoconch of about 3, smooth, convex whorls, 3½ to 4, strongly convex and distinctly shouldered about the upper suture; last whorl large with a sloping but not contracted base; sculpture is reticulate and composed of nearly equal spiral cords and narrow ribs; the nepionic whorls generally have 5 spirals (and a few smaller spirals close to the suture) between wide, flat interspaces; on the last whorl, the spirals increase to 13 to 15 and extend from the upper suture, across the surface to the tip of the anterior canal; the ribs are numerous, narrow, straight to slightly oblique on the spire whorls, distinctly oblique across the face of the last whorl; the ribs number about 18 on the last turns; aperture sub-trigonal, interior generally concealed; columella with at least two, strong folds.

Height 14 mm.; diameter.; 8 mm.
Height 10.5 mm.; diameter 7 mm.

*Remarks.*— Faint traces of varices may be seen on some specimens but this feature may be due to crushing. The aperture is filled and incomplete in our specimens, so that the characters of the inner lip and columellar folds are not known. In form, this species resembles *Cancellaria graciloides* Aldrich from the Wilcox of Alabama, but spire is somewhat shorter.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

### Family TURRIDÆ Adams

### Genus ANDICULA, n. gen.

**Type.- Surcula occidentalis** Woods Plate 7, figs. 3, 4
*Surcula occidentalis* Woods, 1922, p. 106, pl. 16 figs. 7-10.

The following is a description of the genus *Andicula.*

Shell fusiform to pyriform with a high conic spire and a long, curved anterior canal; last whorl large, with a pronounced shoulder keel bearing strong, closely crowded spines or tubercles; surface smooth; anal sinus wide, deep and situated on the shoulder keel as in *Turris.*

*Remarks.*— Two species of large *Surcula*-like gastropods were described by Woods from the Peruvian Eocene as *Surcula occidentalis* and *thompsoni* and a third species was doubtfully referred to the same group by Hanna and Israelsky[11] from the Peruvian Oligocene as *"Surcula mayi".* Similiar species combining pleurotomoid and fusoid characteristics are known, principally from the older Tertiaries of Europe, Africa, North and South America. The relationship of most of these forms is very perplexing and they have been described or classified among the *Turridæ* (*Pleurotomidæ*) and the *Fusidæ.* Their resemblance to the *Turridæ* is principally found in their sinuated lip and growth lines, often developing a typical anal sinus. This sinus is usually *Surcula*-like, that is, lying in a sutural fasciole, more rarely as in *occidentalis,* it is *Turris*-like or situated on the shoulder angle. On the other hand, their approach to the *Fusidæ* is seen in their generally large sized heavy shell, fusoid to fulguroid form and strong shoulder armed with spines and tubercles.

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[11] Hanna and Israelsky 1925, Contribution to the Tertiary Paleontology of Peru, Proc. Calif. Acad. of Sci., 4th series, vol. 14, No. 2.

Certain Eocene species from the southern United States (*Pleurotoma pagodiformis* Heilprin[12] and *Levifusus indentus* Harris[13]) have generally been referred to *Levifusus* Conrad of the *Fusidæ* and Cossmann[14] following this lead, referred to the same genus, the *Fusus Morcki* von Koenen from the Paleocene of Denmark. Other species from the Belgium Eocene to which E. Vincent had proposed a new genus *Surpulofusus* (type *bruxellensis* E. Vin.) are also united by Cossmann with *Levifusus*.

The African forms of which there are two or three species (*Pleurotoma ingens* Mayer-Eymar[17], *Pleurotoma togoensis* Oppenheim[18] and *Clinuropsis diderrichi* E Vincent[19]) are large, fulguroid shells with deep, *Surcula*-like anal sinus and a strongly armed shoulder. *Ingens* was referred to *Pleurotoma* by Mayer-Eymar and Oppenheim, and to *Surcula* by R. Bullen Newton. *Clinuropsis diderrichi* from the older Eocene of the Belgian Congo, is very similiar to *ingens*, but according to R. Bullen Newton[20] differs by its more depressed and less excavated whorls, and the peripheral tubercles are nearer the suture. While describing *diderrichi*, E. Vincent also proposed a new genus *Clinuropsis* with *Pleurotoma ampla* Briart et Cornet as type. This genus which he regarded as belonging to the *Fusidæ* he characterized as follows:—"Coquille fusiform, à spire étagée, plus courte que l'ouverture; tours dentés; suture profonde, canal moyennement allongé, très nettement infléchi à dorite; labre très sinueux, découpé sur la rampe en un sinus large; columella lisse. Type:

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[12] Heilprin 1880, Proc. U. S. Nat. Mus., p. 149, pl., fig, 1., also Harris 1889, Bull. Amer. Pal., vol. 3, No. 11, p. 51, pl. 6, fig. 10.

[13] Harris, 1899, *op. cit.*, p. 52, pl. 7, fig. 1.

[14] Cossmann, 1901, Paleoconch, comp., vol. 4, p. 14.

[17] Mayer-Eymar, 1895, Journ. de Conch., vol. 43, pp. 50, 51, pl. 4, fig. 1, also Oppenheim 1906, Palaeontographica, vol. 30, pt. 3, pp. 332, 333, pl. 24, fig. 26., also R. Bullen Newton 1922, Eocene Mollusca from Nigeria Bull. No. 3, p. 20, pl. 2, figs. 3-5.

[18] Oppenheim, 1915, Beitr. Geol. Erf. Deutsch. Schutzgeb., pt. 12, pl. 5, fig. 5, p. 59.

[19] Vincent, 1913, Contri. a la Paleontologie des Falaises de Landana, Annales du Musee du Congo Belge, Ser. 3, Vol. 1, p. 21, pl. 2, figs. 8, 9, 10, 11.

[20] Newton, R. Bullen, 1922, *op. cit.*, under 5, p. 21.

*Pleurotoma ampla* Briart et Cornet."

Vincent further pointed out the close resemblance of *Clinuropsis diderrichi* to White's[21] figure of *Fusus* (*Serrifusus*) from eastern Brazil. White's figure 1, is a cross section of a large fulguroid form with a sharp shoulder armed with stout spines and a slight curved anterior canal. Another South American species is *Pleurotoma acutinoda* Philippi[22] of Lebu Chila, a slender form probably related to *thompsoni.*

On close study, the two Peruvian species, *thompsoni* and *occidentalis* appear to belong to different groups. In *thompsoni,* the form is slender, fusoid, the anal sinus is normally *Surcula*-like, although in some cases lying on or just above the shoulder angle. Young shells are even more *Fusus*-like, the whorls being sculptured with strong spirals and the posterior sinus is nearly lacking. In *occidentalis,* the form is broad with a large body-whorl, the upper surface of the whorls is practically smooth even in young shells, and the anal sinus is constantly deep and *Turris*-like. *Surcula thompsoni* appears to belong to the *Fusidæ* and provisionally may be placed in Vincent's genus *Clinuropsis. Surcula occidentalis* on the other hand, is decidedly more pleurotomoid than any of the described species and is here taken as the type of a new genus belonging with the *Turridæ.*

The relationship of *"Surcula" mayi* Hanna and Israelsky from Mancora is doubtful. Only the type specimen is known which is weathered and does not show the form of the growth lines. I am inclined to regard it as a fasciolaroid. Probably to this group of *Surcula-Fusus*-like shells should be included the *Euthriofusus spinosus* Suter[15] from the Miocene of New Zealand.

*Andicula occidentalis* appears to be a true pleurotomoid differing from the above mentioned species by its deeper anal sinus, constantly situated on the shoulder angle. From true *Tur-*

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[21] White, 1888, Archiv, Mus. Nacion, Rio de Janeiro, vol. 7, p. 135, pl. 18, figs. 1, 2.

[22] Philippi, 1887, Die Tertiaren und Quartaren Versteinerungen Chiles, p 37, pl. 1, fig. 8.

[15] Suter, 1917, Description of New Tertiary Mollusca occurring in New Zealand, Pa. Bull. No. 5, N. Zeal. Geol. Survey, p. 24, pl. 4, figs. 1, 2.

*ricula* (*Surcula*) as typified by the recent *P. javana* Linnaeus, *Andicula* differs by its larger size, fulguroid form, armed shoulder and deep *Turris*-like anal sinus. The smaller specimens of *occidentalis* closely resemble certain species of *Pleurotomella* Verrill, (for example *P.* (*Gymnobela*) *agonia* Dall[16]), but the genus *Pleurotomella* is typically a deep sea type more or less pyriform with a fairly high conic spire, a long, moderately curved anterior canal and the shoulder armed with strong, closely spaced spines or tubercles. The growth lines are very sinuous, forming a wide, deep and pronounced sinus on the armed shoulder. There is also a smaller sinus midway between the shoulder and the tip of the anterior canal.

### Genus DRILLIA Gray (sensu lato)

**Drillia parina**, n. sp. Plate 8, figs. 12, 13, 14

Shell thin, *Mitra*-like in form, with a long, pointed spire and slender, anterior canal; protoconch acute, pointed, smooth of about 4, convex whorls; post-nuclear whorls 4 or more, only slightly convex so that profile of the spire is nearly straight; sutures distinct, bordered on the anterior side by a spiral ridge; sutural fasciole fairly wide, shallow, bordered above by the sutural cord or ridge and scarcely differentiated below by the weak shouldering or angulation of the whorls; sculpture of the spire whorls consists of about 11, weak riblets between the fasciole and lower suture, but gradually fading out on the shoulder of the last whorl; the perdominant sculpture is by beaded spirals which cover the whole surface except the sutural fasciole on which the spirals are simple; on the last whorl, there are 3 spirals (the lower heavy) on the sutural ridge, 5 simple spirals on the sutural fasciole and 14 or 15, beaded spirals on the surface below the shoulder to the tip of the anterior canal; anterior canal long, slender; columella smooth; anal sinus in the sutural fasciole.

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[16] Dall, Bull. Mus. Comp. Zool., vol. 43, p. 278, pl. 1, fig. 6.

Length 13.5 mm. (3 whorls); diameter 6 mm.; aperture 7 mm.
Length 17 mm. (estimated); aperture 9 mm. (estimated)

*Remarks.*— Our specimens of this interesting species are fragmentary. In form and sculpture, the shell resembles a *Scobinella* but the pillar appears to be perfectly smooth. The anterior canal is long and slender.

*Locality and Geologic Occurrence.*— Saman formation, Saman conglomerate near Negritos.

### Genus DAPHNELLA Hinds

**Daphnella salina**, n. sp. Plate 8, figs. 5, 10

Shell small, slender, the spire and aperture about equal in length; tip of spire broken in our specimens; sutures distinct between flattened or slightly convex whorls; surface is sculptured with strong, equal, spiral threads between wider intervals; these spirals number about 17 or 18 on the back of the last whorl and 4 or 5 on the spire whorls; in addition the spire whorls have strong, axial threads of the same size as the spirals but these become obsolete or irregular on the penultimate and last whorl; aperture narrowly elongate, the outer lip heavy and thickened with a shallow sinus near its posterior end; canal hardly differentiated and slightly recurved at the tip.

Heigth 12 mm. (incomplete); diameter 5.5 mm.; aperture 7.5 mm.
Height 14 mm. (estimated length if perfect)
Height 12 mm. (incomplete); diameter 5.5 mm.; aperture 8 mm.
Height 16 mm. estimated length)

*Remarks.*— This species closely resembles the figure of *D. bartschi* Dall[23] recent off the Lower Californian coast, but is larger, more coarsely sculptured and more slender.

*Locality and Geologic Occurrence.*— Saman formation, Saman conglomerate at Negritos.

**Daphnella eupelia**, n. sp. Plate 8, fig. 2

Shell small, elevated with convex whorls and distinct sutures; protoconch unknown; post nuclear whorls preserved 3, evenly convex, the last or body whorl with descending sutures; body whorl sub-elliptical, the base or anterior portion evenly contracted or produced; sculpture consists or regular and strong spiral cords, the upper ones more or less nodulated by faint, longitudinal riblets, the earliest spire whorls preserved have about 5 spirals, increasing to 7 on the next, 8 on the penultimate and 16 or more on the body whorl; on the early whorls, the ribs are quite well developed. numerous (10 to 12), straight and pass from suture to suture; on the later whorls, the riblets are still more numerous, irregular and gradually vanish into the growth lines; aperture destroyed but showing remains of a much thickened outer lip.

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[23] Dall, 1919, Proc. U. S. Nat. Mus., vol. 56, p. 74, pl. 19, figs. 4, 5.

Length 8 mm.; diameter 3.5 mm.

*Remarks.*— A small species with strongly convex whorls and fairly coarse spiral cords and fainter axial riblets; the outer lip was probably strongly thickened.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

### Genus MANGELIA Risso (sensu lato)

**Mangelia jabonillalensis**, n. sp. Plate 8, figs. 6, 8, 9

Shell small, fusoid, the spire and aperture about equal in length; spire high acute, composed of about 7, or 8, convex whorls between sharp, distinct sutures; protoconch conic, pointed of 4 or 5, smooth convex whorls which rapidly increase in size; on the last quarter turn of the final nuclear whorl, faint ribs make their appearance, shortly followed by spirals; post-nuclear whorls about 3 in number; these are sculptured with equal, regular, longitudinal ribs which pass from suture to suture and across the base of the last whorl to the anterior canal; they number about 15 on the body whorl; the ribs and interspaces are crossed by a primary set of spiral threads separated by wide banded intervals which carry 4 or more fine secondaries; canal of moderate length, slightly twisted and with a deep, anterior sinus; aperture lanceolate, the outer lip thin or thickened simply by the ribs.

Length 10.5 mm.; aperture 5 mm.; diameter 4. 75.

*Remarks.*— This is a small *Phos*-like species abundant in the

Upper Restin of Jabonillal. The lip appears to be thin, or thickened simply by the ribs.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

### Genus TURRICULA Schumacher (sensu lato)

**Turricula bonilla** Plate 8, fig. 1

Shell small, with a fairly long spire and shorter aperture; protoconch acute, pointed, of 4, convex, smooth whorls rapidly passing on the last quarter turn into the post-nuclear stage; post-nuclear whorls 4, sculptured with ribs and fine spirals; sutures linear, distinct, bordered by a ridge or double cord; sutural fasciole present, sloping but not sharply limited on the lower side; post-nuclear whorls convex, roughly shouldered about the middle; last whorl is rather large, with a sloping base and a fairly long anterior canal; longitudinal sculpture of about 8 ribs or folds, which extend from the sutural cord to the lower suture, but fading out on the base of the last whorl; this sculpture is overrun by finer, wavy spiral threads, slightly finer on the fasciole; anal sinus indicated by the growth-lines lying in the sutural fasciole; anterior canal long, straight.

Length 7 mm.; diameter 2. 5 mm.; aperture 2. 75 mm.

*Remarks.*— The tip of the anterior canal is broken so that the length of the perfect shell was probably about 8 mm. In its form and in its long, straight, anterior canal, the species resembles a *Turricula,* and it is provisionally referred to that genus.

*Locality and Geologic Occurrence.*— Restin formation, Jabonillal.

### Phylum MOLLUSCOIDEA

### Class BRACHIOPODA Dumeril

### Order TELOTREMATA Beecher

### Family MEGATHYRIDÆ Dall

### Genus ARGYROTHECA Dall

**Argyrotheca berryi,** n. sp. Plate 1, figs. 9, 10, 11

Shell small, *Orthis*-like in form, inequivalve, thick and heavy; ventral valve largest, convex with a sharp pointed beak and wide cardinal area; dorsal valve flat, usually with a faint, medial furrow and practically no hinge area; anterior or hinge margin nearly straight, the posterior well-rounded forming nearly a true circle, the width of the valves as a whole, slightly greater than the height; cardinal area, restricted almost entirely to the ventral valve is broadly trigonal, flattened to excavated, and with a wide deltidial opening, usually much eroded; internal characters concealed or badly eroded; surface smooth, but densely punctate, and in some specimens with very faint costæ.

Height 2.50 mm.; width 3.50 mm.; dorsal valve
Height 2.75 mm.; width 3.50 mm.; ventral valve
Thickness of both valves 1.50 mm.

*Remarks.*— *Argyrotheca berryi* is a small *Orthis*-like species quite abundant in the Saman conglomerate at Caleto Sal, associated with its typical fauna of *Liothyrina peruviana* Olsson and species of *Discocyclina* and *Asterocyclina.* Three other species of this genus are known from the American Eocene, *A. dalli* Aldrich[24], described from a right valve collected at Hatchetigbee Bluff Alabama, it is nearly twice the size of *berryi* and subcircular in form; *A. dalli* Cooke[25] from the Upper Eocene of St. Bartholomew, a large coarsely ribbed species and *A. powersi* Gardner[26] from the Midway of Butler's salt dome Texas. *A. schurcherti* Dall[27] occurs in the Chesapeake Miocene of Jackson's Bluff, Florida and several species are known in the recent American fauna.

The genus *Argyrotheca* is well represented in the European Tertiaries. Cossmann[28] figures 11 species from the Parisien Eocene and von Kœnen[29] 3 species and varieties from the Lower Oligocene of Northern Germany.

This species is named for Mr. E. Willard Berry of Johns Hopkins University.

*Locality and Geologic Occurrence.*— Saman formation, Caleto Sal.

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[24] Aldrich, 1911, Bull. Amer. Pal., vol. 5, 22, p. 13, pl. 5, figs. 9, 10.

[25] Cooke, 1919, Carnegie Institution of Washington, No. 291, p. 152, pl. 16. figs. 5 a-c.

[26] Gardner, 1925, Amer. Journ. Sci., 5th series, vol. 10, p. 134-138, figs. 1-8.

[27] Dall, 1903, Trans. Wagner Free Inst., vol. 3, pt. 6, p. 1539, pl. 58, fig| 8.

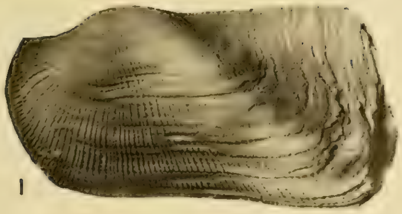
[28] Cossmann and Pissarro, 1913, Icon, des Coquilles des Environs de Paris, pl. 62, figs. 5-1 to 5-11.

[29] Koenen, 1894, Abhandl. d. geol. Landesanstalt, Bd. X, Heft. 6, taf. 11C.

# EXPLANATION OF PLATES

## Explanation of Plate 1

| Fig. | | Page |
|---|---|---|
| 1. | **Arca (Barbatia) saladoensis,** n. sp. Holotype, length 21 mm. Restin formation, Que. Salado | 4 |
| 2. | **Arca (Barbatia) saladoensis,** n. sp. Cotype, length 19 mm. | 4 |
| 3. | **Arca (Barbatia) saladoensis,** n. sp. Cotype, length 23.5 mm. | 4 |
| 4. | **Arca (Argina) samanensis,** n. sp. Cotype, length 23 mm. Saman formation, Casa Saman | 5 |
| 5. | **Arca (Argina) samanensis,** n. sp. Holotype, length 21 mm. Saman formation, Casa Saman | 5 |
| 6. | **Diplodonta caboblanca,** n. sp. Holotype, length 26 mm. Restin formation, Cabo Blanco | 10 |
| 7. | **Lucina corbula,** n. sp. Holotype, length 34.5 mm. Restin formation, Que. Conventus | 7 |
| 8. | **Diplodonta caboblanca,** n. sp. Cotype, length 23 mm. | 10 |
| 9. | **Argyrotheca berryi,** n. sp. Cotype, width 2.5 mm. Saman formation, Caleta Sal. | 34 |
| 10. | **Argyrotheca berryi,** n. sp. Holotype, width 3.5 mm. | 34 |
| 11. | **Argyrotheca berryi,** n. sp. Cotype, width 2.5 mm. | 34 |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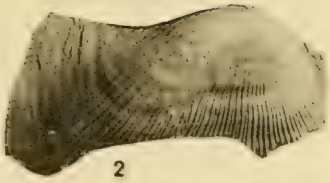
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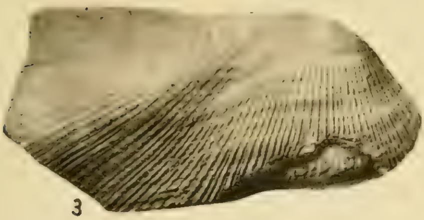
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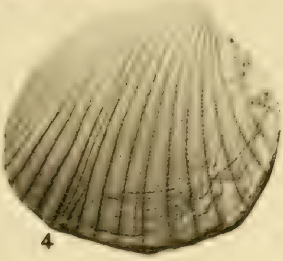
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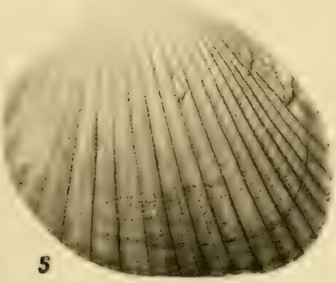
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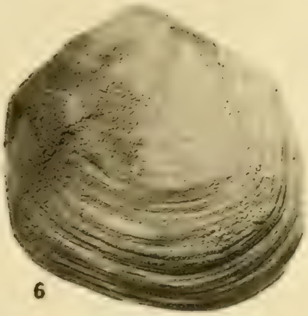
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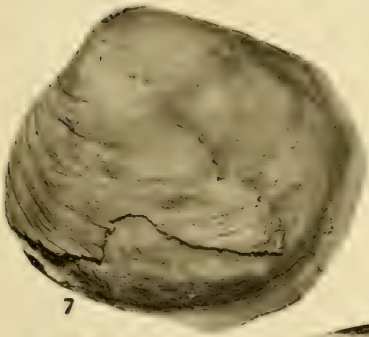
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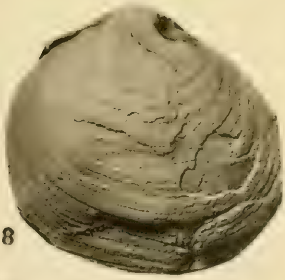
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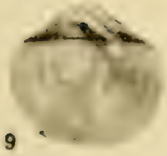
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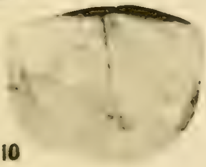
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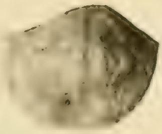
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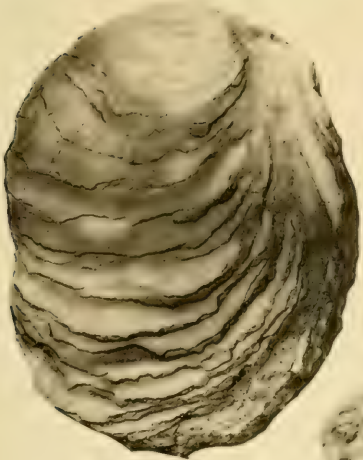
## EXPLANATION OF PLATE 2

| FIG. | | PAGE |
|---|---|---|
| 1. | **Ostrea restinensis**, n. sp. Exterior of upper valve, length 78 mm. Restin formation, Restin. | 6 |
| 2. | **Ostrea restinensis**, n. sp. Exterior of lower valve. Holotype. Length 71 mm. Restin formaiton, Restin. | 6 |
| 3. | **Ostrea quiroga**, n. sp. Interior of upper valve, Holotype. Length 162 mm. Salina formation, Negritos. | 6 |
| 4. | **Ostrea quiroga**, n. sp. Exterior of lower valve, Cotype. Length 94 mm. Salina formation, Negritos. | 6 |
| 5. | **Ostrea quiroga**, n. sp. Interior of same specimen as figure 4 | 6 |



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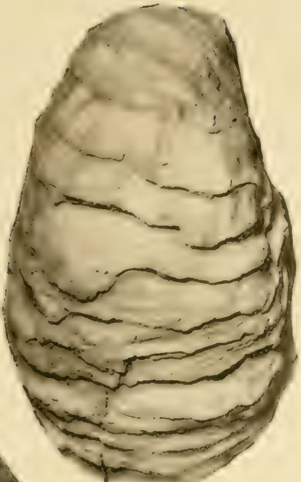

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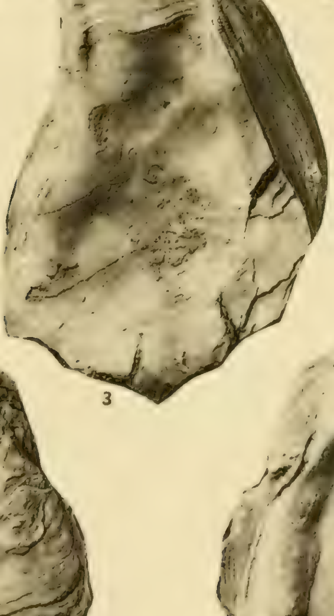

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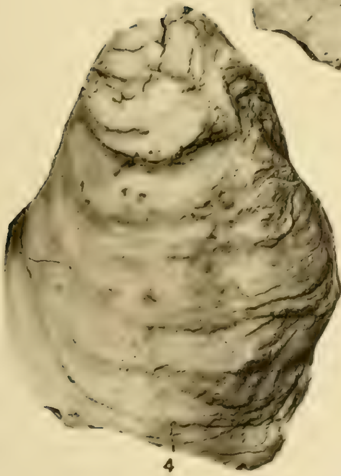

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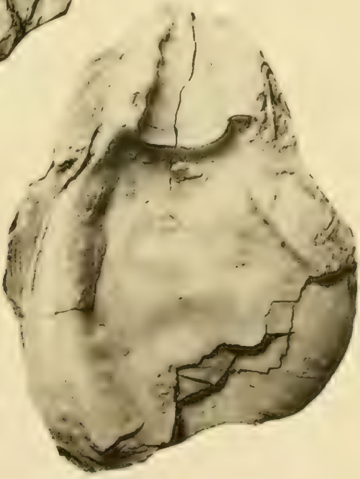

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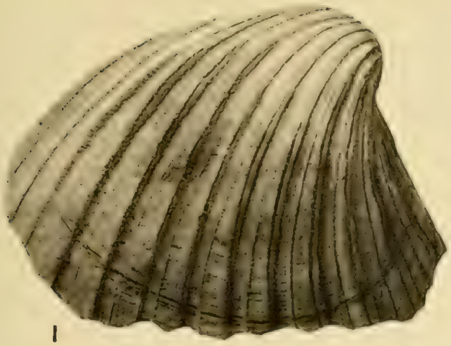
## EXPLANATION OF PLATE 3

| FIG. | | PAGE |
|---|---|---|
| 1 | **Venericardia planicosta**, var. **labreaensis**, n. var. Right valve, Cotype. Length 45 mm. Negritos formation, La Brea. | 7 |
| 2. | **Venericardia planicosta**, var. **labreaensis**, n. var. Left valve, Holotype. Length 36.5 mm. Negritos formation, La Brea. | 7 |
| 3. | **Phacoides (Miltha) conventus**, n. sp. Holotype. Length, 29 mm. Restin formation, Que. Conventus. | 9 |
| 4. | **Venericardia talara**, n. sp. Holotype, right valve. Length 31 mm. Restin formation, Negritos. | 8 |
| 5. | **Venericardia talara**, n. sp. Holotype, left valve. | 8 |
| 6. | **Cardium (Cerastoderma) himertum**, n. sp. Holotype. Length 20.5 mm. Restin formation, Que. Salado. | 11 |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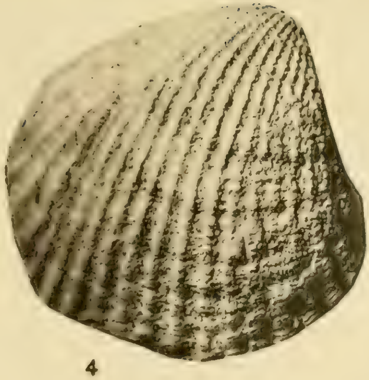
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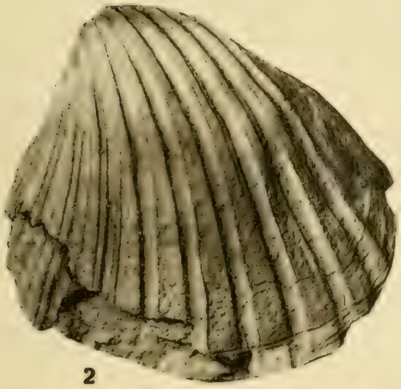
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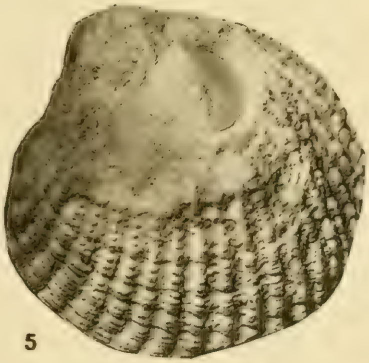
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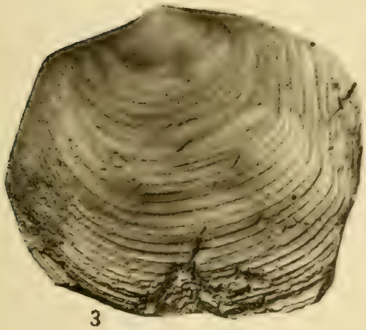
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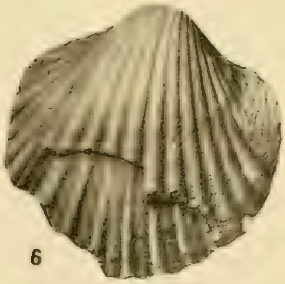
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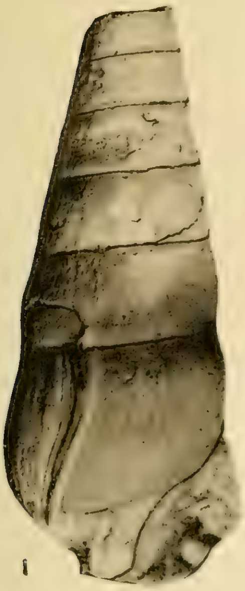
## EXPLANATION OF PLATE 4

| FIG. | | PAGE |
|---|---|---|
| 1. | **Cerithium læviusculum** Gabb. Ventral view of a normal specimen, with a single varix. About natural size. Saman formation. Paita. | 15 |
| 2. | **Cerithium læviusculum** var. **saladoense,** n. var. Holotype, showing the slightly expanded and sinuated lip. About natural size. Restin formation, Que. Salado. | 16 |
| 3. | **Cerithium læviusculum** var. **saladoense,** n. var. Cotype, slightly enlarged view of an average specimen. Que. Salado. | 16 |
| 4. | **Cerithium læviusculum,** Gabb. Ventral view of a normal specimen, showing the thickened or callused inner lip and anterior canal, about natural size. Paita. | 15 |
| 5. | **Woodsalia negritosensis,** Woods. Somewhat enlarged view of the right side to show the curved growth lines. Negritos formation. Negritos. | 13 |
| 6. | **Woodsalia negritosensis,** Woods. Somewhat enlarged view of the ventral side to show the continuous and thickened peristome Negritos. | 13 |
| 7. | **Neritina stadnichenkiæ,** n. sp. Ventral view. Holotype. Diameter 23.5 mm. Restin formation, Que. Salado. | 11 |
| 8. | **Neritina stadnichenkiæ,** n. sp. Dorsal view. Holotype. | 11 |



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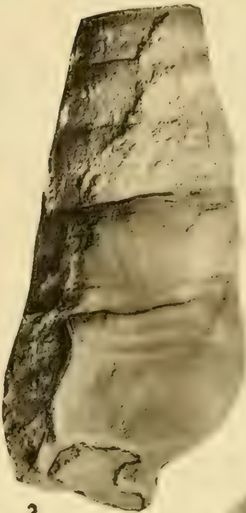

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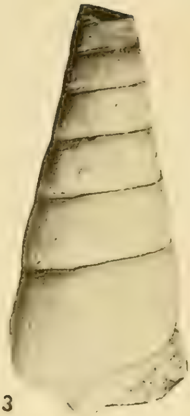

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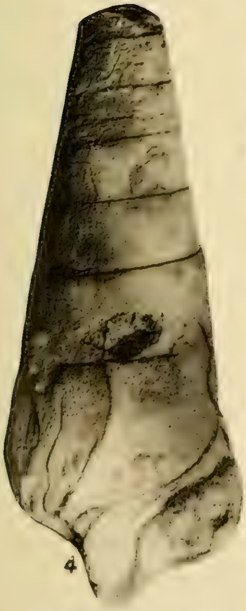

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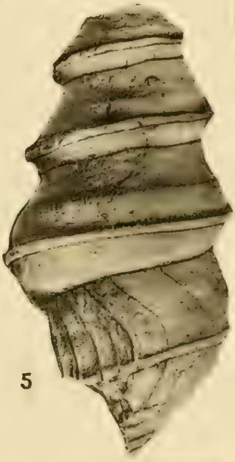

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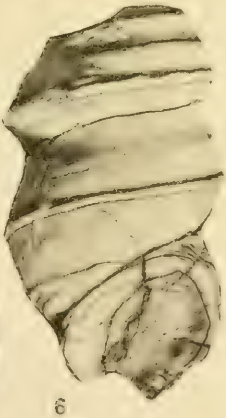

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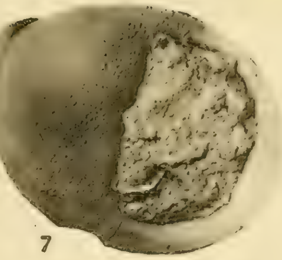

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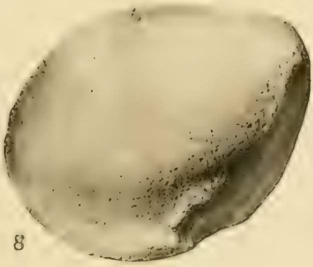
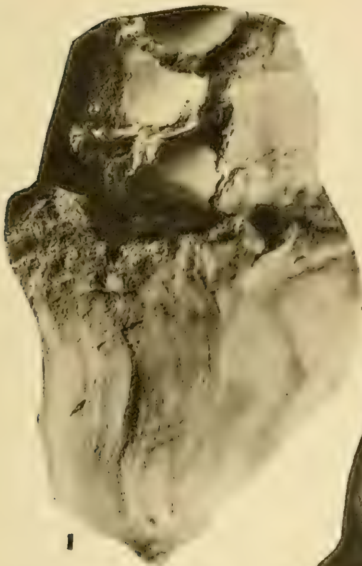


8

## EXPLANATION OF PLATE 5

| FIG. | | PAGE |
|---|---|---|
| 1. | **Cerithium (Perucerithium) restinense**, n, sp. Holotype, last two turns of a large specimen with the slightly expanded and sinuated lip. Parinas formation. Cabo Blanco. | 18 |
| 2. | **Cerithium (Perucerithium) restinense**, n. sp. Ventral view of an eroded specimen. Length 106 mm. The spire whorls are eroded, only the last whorl preserving the sutural shoulder. | 18 |
| 3. | **Cerithium (Perucerithium) restinense** n. sp. A portion of the spire whorls to show the scalar sutures. | 18 |
| 4. | **Cerithium (Perucerithium) restinense**, n. sp. Cotype. Length 87 mm. | 18 |
| 5. | **Strombus burhinus**, n. sp. Holotype, dorsal view. Restin formation. Restin. | 24 |
| 6. | **Strombus burhinus**, n. sp. Holotype, ventral view. | 24 |
| 7. | **Cerithium (Perucerithium) restinense**, n. sp. Spire whorls. | 18 |



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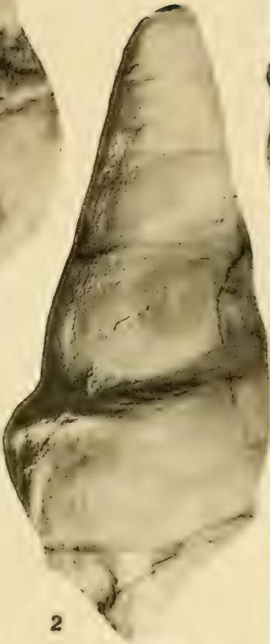

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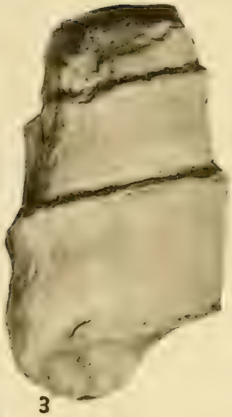

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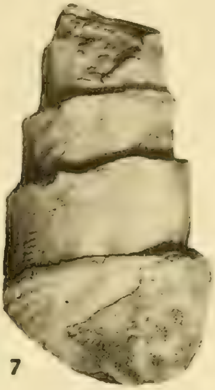

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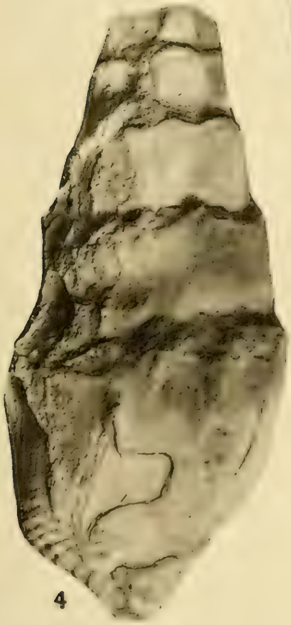

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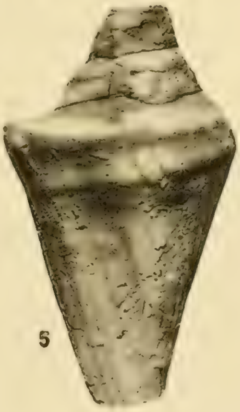

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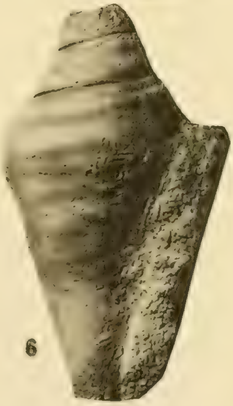

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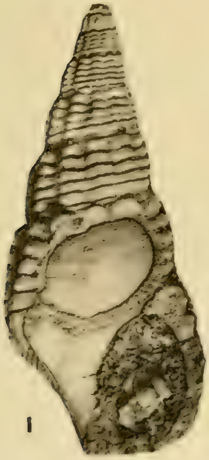
## Explanation of Plate 6

| Fig. | | Page |
|---|---|---|
| 1. | **Diastoma geositta**, n. sp. Ventral view of Holotype. Length 39 mm. Parinas formation, Keswick Hills. | 22 |
| 2. | **Diastoma geositta**, n. sp. Dorsal view of same specimen | 22 |
| 3. | **Diastoma furnaria**, n. sp. Dorsal view of Holotype. Length 33 mm. Restin formation. Jabonillal. | 23 |
| 4. | **Diastoma elænia**, n. sp. Holotype. Length 20 mm. Restin formation. Jabonillal. | 23 |
| 5. | **Diastoma elænia**, n. sp. Cotype. Length 15 mm. | 23 |
| 6. | **Diastoma elænia**, n. sp. Cotype. Length 14 mm. | 23 |
| 7. | **Diastoma elænia**, n. sp. Cotype, of early post-nuclear whorls. Length 11.75 mm. | 23 |
| 8. | **Rhinoclavis (Hopkinsiana) costata** Woods. Immature specimen. Length 22 mm. Salina formation. Negritos. | 18 |
| 9. | **Cerithiopsis quemada**, n. sp. Holotype. Length 9 mm. Restin formation. Jabonillal. | 21 |
| 10. | **Rhinoclavis (Hopkinsiana) costata** Woods. Length 28 mm. | 18 |
| 11. | **Rhinoclavis (Hopkinsiana) costata** Woods. Length 29 mm. | 18 |



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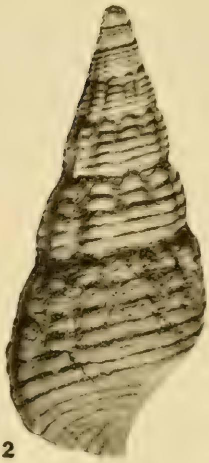

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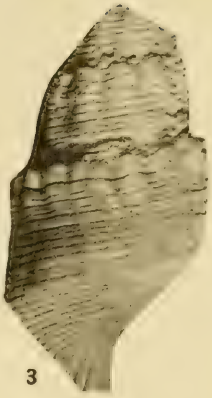

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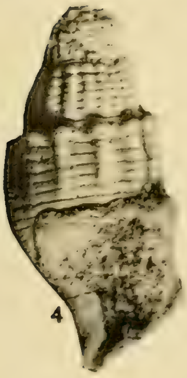

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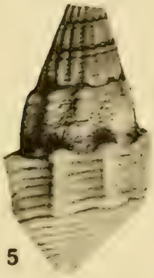

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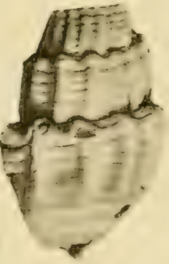

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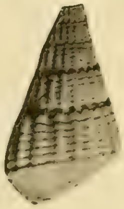

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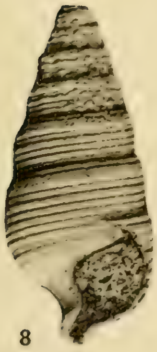

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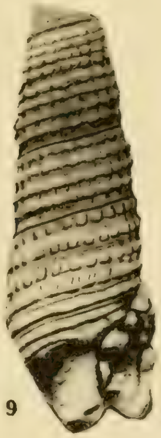

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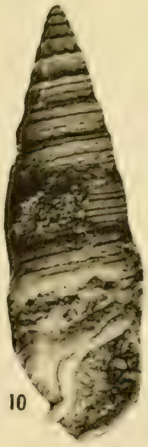

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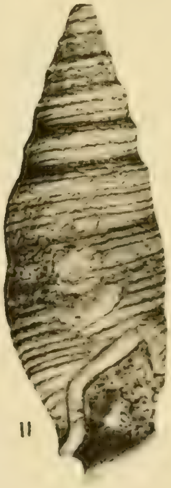
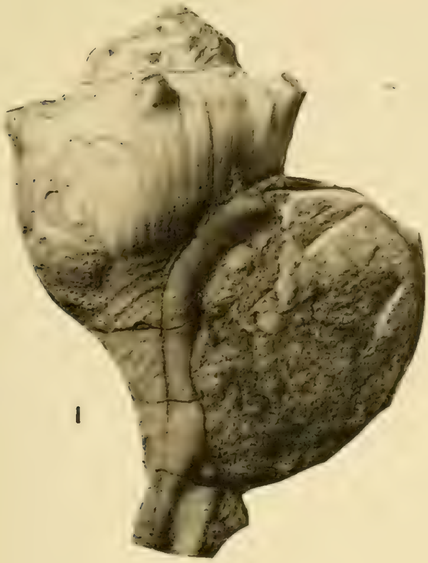


11

## EXPLANATION OF PLATE 7

| FIG. | | PAGE |
|---|---|---|
| 1. | **Levifusus mallacus**, n. sp. Holotype, ventral view, somewhat enlarged. Restin formation, Que. Salado. | 26 |
| 2. | **Levifusus mallacus**, n. sp. Dorsal view of same specimen. | 26 |
| 3. | **Andicula occidentalis** Woods. Length 56 mm. Salina formation, Negritos. | 28 |
| 4. | **Andicula occidentalis** Woods. Ventral view. Length 62 mm. | 28 |



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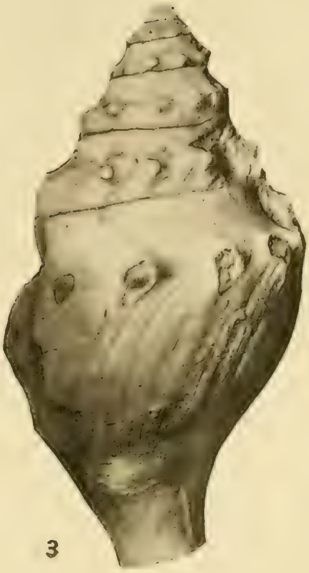

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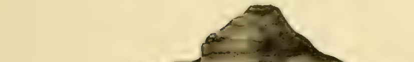

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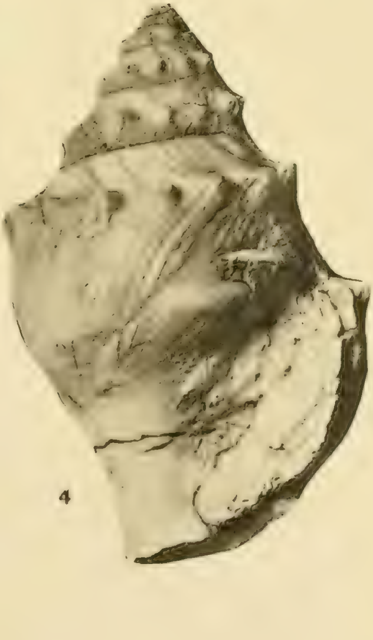
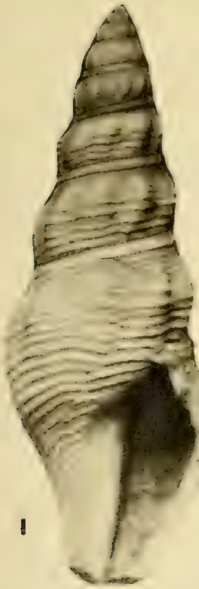


4

## EXPLANATION OF PLATE 8

| FIG. | | PAGE |
|---|---|---|
| 1. | **Turricula bonilla**, n. sp. Holotype. Length 7 mm. Restin formation. Jabonillal. | 34 |
| 2. | **Daphnella eupelia**, n. sp. Holotype. Length 8 mm. Restin formation. Jabonillal. | 32 |
| 3. | **Admete (Bonellitia) luffa**, n. sp. Holotype. Length 14 mm. Restin formation. Jabonillal. | 27 |
| 4. | **Admete (Bonellitia) luffa**, n. sp. Cotype 11 mm. | 27 |
| 5. | **Daphnella salina**, n. sp. Holotype. Length 12 mm. Saman formation. Negritos. | 32 |
| 6. | **Mangelia jabonillalensis**, n. sp. Holotype. Length 11 mm. Restin formation. Jabonillal. | 33 |
| 7. | **Harrisianella peruviana**, n. sp. Holotype. Length 25.5 mm. Saman formation. Caleto Sal. | 21 |
| 8. | **Mangelia jabonillalensis**, n. sp. Cotype. Length 10 mm. | 33 |
| 9. | **Mangelia jabonillalensis**, n. sp. Cotype. Length 10 mm. | 33 |
| 10. | **Daphnella salina**, n. sp. Cotype. Length 12.5 mm. | 32 |
| 11. | **Peruficus lagunitensis**, n. sp. Holotype. Length 21 mm. Saman formation. Lagunitas. | 26 |
| 12. | **Drillia parina** n. sp. Cotype. Length 13 mm. Saman formation. Negritos. | 31 |
| 13. | **Drillia parina**, n. sp. Holotype. Length 13.5 mm. | 31 |
| 14. | **Drillia parina**, n. sp. Cotype. Length 13.5 mm. | 31 |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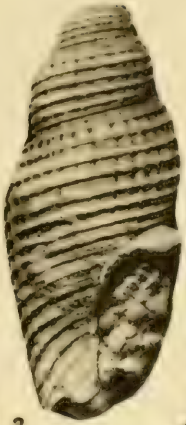
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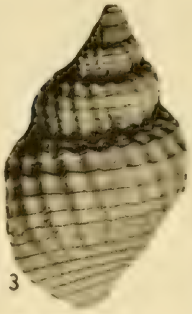
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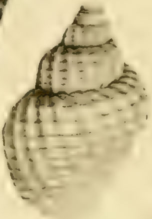
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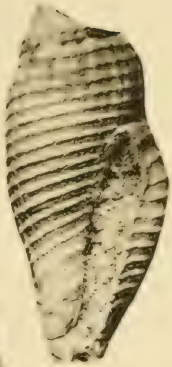
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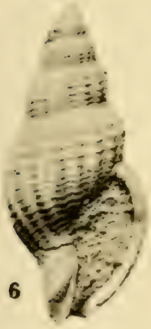
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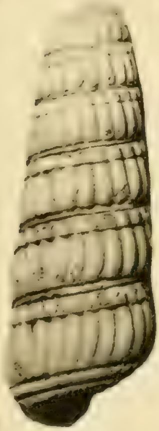
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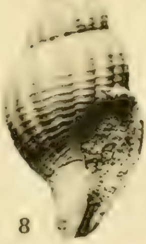
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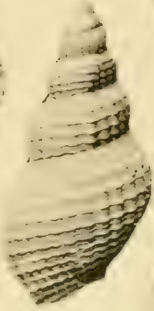
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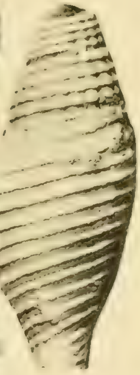
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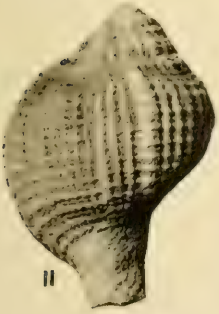
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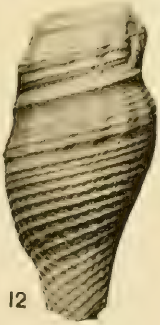
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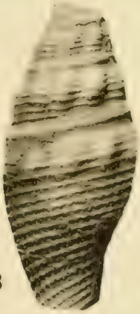
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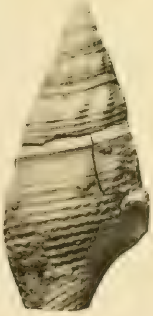
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# BULLETINS

OF

# AMERICAN PALEONTOLOGY

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## VOL. XV

* * *

## No. 57a

*November 24, 1929*

Harris Co.
Ithaca, N. Y.
U. S. A.

BULLETINS
OF
AMERICAN PALEONTOLOGY

Vol. 15

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No. 57 a

# A NEW OLIGOCENE BRACHIOPOD FROM MEXICO

By W. S. Cole

*November 24, 1929*

Harris Co.
Ithaca, N.Y.
U. S. A.

During the spring of 1927, I had the opportunity of collecting some samples from the *Lepidocyclina gigas* var. *mexicana* Cushman, *L. undosa* Cushman zone of the Meson formation of Mexico. This formation is approximately equivalent to the Glendon formation of Alabama, Florida and Georgia and of, at least, the lower part of the Antigua formation of Antigua.[1]

On examination of these samples, I found besides the Foraminifera, one species of Brachiopod belonging to the genus *Argyrotheca*. The abundance of this Brachiopod, together with its very perfect state of preservation, makes it desirable to describe this form.

**Argyrotheca wegemanni**, n. sp. Plate 1

Shell small, inequivalve, coarsely punctate. Pedicle valve the larger, flat, with a moderately elevated, bluntly pointed beak; brachial valve inflated with a wide straight cardinal margin; cardinal area is broadly trigonal with a very wide delthyrium; deltidial plates small, widely separated. Septum in ventral valve low and apparently uniform in elevation from the beak to the anterior margin; in the dorsal valve, septum very high, reaching an apex very near the anterior portion of the shell. Dental sockets on the dorsal valve weakly developed. Adults have 6 radial folds, making the anterior margin serrate; in young specimens, a slight fold developed, in the brachial valve, the pedicle valve, flat; in intermediate stages, a variation from two to the six folds of the adult.

Height 1.5mm.; width 1.8mm.; brachial valve (type).
Height 2.2mm.; width 1.8mm.; pedicle valve (type).
Thickness of both valves .6mm. (type).

*Type locality.*—From the *L. gigas* var. *mexicana* Cushman—*L. undosa* Cushman zone between km. posts 17-18 on the Aguila Petroleum Company's narrow-gauge railroad between Potrero and Tanhuijo.

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[1] Vaughan, T. W., Bull. Geol. Soc. Am., vol. 35, p. 732, 1924.

*Cotypes.*—My personal collection, U. S. National Museum and Cornell University Museum.

This species is named in honor of Mr. Carroll H. Wegemann, Chief Geologist of the Pan-American Petroleum and Transport Co., by whose permission this paper is published.

Associated with *Argyrotheca wegemanni* are numerous large and small Foraminifera. The fauna indicates a very shallow, tropical sea. Some of the more common described Foraminifera are:

*L.* (*Lepidocyclina*) *parvula* Cushman.
*L.* (*Nephrolepidina*) *gigas* var. *mexicana* Cushman.
*undosa* Cushman
*crassata* Cushman
*Heterostegina antillea* Cushman.
*Eponides byramensis* (Cushman).
*Marginulina mexicana* Cushman.
*Siphonina advena* Cushman.
*Uvigerina byramensis* (Cushman).

The genus *Argyrotheca* is well represented in the European Tertiaries and by nine species in the Tertiaries of the Americas. They are *A. dalli* Aldrich[2] (Eocene Alabama), *A. dalli* Cooke[3] (Eocene, St. Bartholomew), *A. powersi* Gardner[4] (Eocene, Texas) *A. berryi* Olsson,[5] *A. chica* Berry, *A. peruviana* Berry[6] (Eocene. Peru), *A. beecheri* (Clark), *A. plicatilis* (Clark)[7] (formerly considered Cretaceous, now Eocene) and *A. schucherti* Dall[8] (Miocene, Florida). In all probability, *A. peruviana* should be referred to *A. berryi* Olsson. There are also several species known from the recent American fauna.

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[2] Aldrich, T. H., Bull. Am. Pal., vol. 5, No. 22, pp. 13-14, pl. 5, figs. 9-10, 1911.

[3] Cooke, C. W., Carnegie Institution of Washington, No. 291, p. 152, pl. 16, figs. 5a-c, 1919.

[4] Gardner, J., Am. Jour. Sci., vol. 10, 5th series, pp. 134-138, figs. 1-8, 1925.

[5] Olsson, A. A., Bull. Am. Pal., vol. 15, No. 57, pp. 34-35, pl. 1, fig. 9, 10, 11, 1929.

[6] Berry, E. W., Jour. Was. Acad. Sci., vol. 19, No. 12, p. 239, figs. 10, 11, and 5-9, 1929.

[7] Clarke, W. B., Johns Hopkins Univ. Cir., vol. 15, No. 121, p. 3, fig. C and D, 1895.

[8] Dall, W. H., Trans. Wagner Free Inst. Sci. Phil., vol. 3, pt. 4, p. 1539, pl. 58, fig. 8, 1903.

[9] Thomas, A. O., Sci., n. s., vol. 54, p. 309, Sept. 1921.

Although Thomas[9] in a short communication to Science reports Brachiopods of the genera *Argyrotheca, Terebratulina* and *Liothyrina* from the Antigua limestone of Half Moon Bay, *A. wegemanni* is the first of this genus to be described from the American Oligocene.

Cossmann[10] figures 11 species from the Parisian Eocene and 4 species from the Eocene of Cotentin.[11]; von Koenen[12] records 3 species and varieties from the lower Oligocene of North Germany.

While *A. wegemanni* is distinct from the above mentioned American species, it is very near two European forms, namely, *A. crassicostata* (Baudon) and *A. Baudoni* (Desh). It is much smaller in size than either of these, and has typically a much larger delthyrium. The radial folds are not so strongly developed as in *A. Baudoni* and it lacks the sharply crenulated anterior margin of that form. *A. wegemanni* has stronger radial folds than *A. crassicostata* with consequently a more serrate anterior margin.

*A. wegemanni* is evidently sharply delimited in its vertical range, and I have not found it in any other samples than those from the true *L. gigas* var. *mexicana, L. undosa* zone of the Meson formation. It should be a splendid form for use in correlation, if it is found elsewhere.

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[9] Thomas, A. O., Sci., n. s., vol. 54, p. 309, Sept. 1921.

[10] Cossmann M. and Pissarro, G., Ico., des Coquilles des Environs de Paris, pl. 62, figs. 5-1 to 5-11, 1913.

[11] Cossman M. and Pissarro, G., Bull. Geol. Soc. de Normandie, vol. 24, pp. 65, 66, pl. 19, 1905.

[12] von Koenen, Abhandl. d. geol. Landesanstalt, Bd. X, Heft. C, taf. IIC.

Cornell University, Ithaca, N. Y.
September 27, 1929.

## EXPLANATION OF PLATE 1

**Argyrotheca wegemanni**

1. View of brachial valve, x 10.
2. View of brachial valve of younger specimen x 10.
3. View of brachial valve of very young specimens x 10.
4. View of pedicle valve of same specimen as fig. 3, x 10.
5. View of brachial valve of adult specimen (type), x 10.
6. View of pedicle valve of adult specimen (type) x 10.
7. View of pedicle valve of type specimen, greatly enlarged to show structure, x 20.

8-9-10. View of pedicle valves of different specimens x 10.

11. Internal view to show median septum x 10.
12. Internal view of another specimen x 10.
13. Internal view of same specimen as figure 12, greatly enlarged x 20.
14. Side view of large specimen x 10.
15. Side view of small specimen, greatly enlarged x 20.

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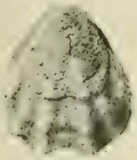
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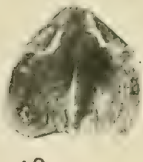
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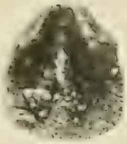
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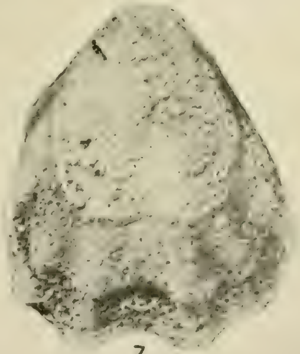
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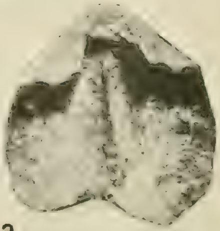
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# Some Small Foraminifera from the Meson Formation of Mexico

By W. STORRS COLE and RUTH GILLESPIE

*February 28, 1930*

Harris Co.,
Ithaca, N. Y.
U. S. A

# SOME SMALL FORAMINIFERA FROM THE MESON FORMATION OF MEXICO

by

W. Storrs Cole[1]
and
Ruth Gillespie[2]

## INTRODUCTION

The senior author was able to collect several samples from the *Lepidocyclina gigas* var. *mexicana, L. undosa* zone of the Meson formation of Mexico, during his work as micro-paleontologist for the Huasteca Petroleum Company at Tampico, Mexico.

Upon examination, these samples yielded a considerable fauna of large and small foraminifera, together with numerous individuals of a minute brachiopod which has been described by the senior author as *Argyrotheca wegemanni* Cole[3].

The large foraminifera indicate the correlation of this portion of the Meson formation with similar formations in the United States and the West Indies. No attempt will be made in this paper to describe any of the large foraminifera, as Dr. Vaughan in a personal communication, has informed the senior author that he intends to monograph them. The following list of large foraminifera as identified by us from our samples, is merely presented for correlation purposes:

| | |
|---|---|
| **Lepidocyclina (Lepidocyclina) parvula** Cushman | Pl. 1, figs. 4, 5 |
| **Lepidocyclina (Nephrolepidina) undosa** Cushman | Pl. 1, figs. 1, 2 |
| **undosa** Cushman var. **tumida** Vaughan | |
| **gigas** Cushman | Pl. 1, fig. 8 |
| **gigas** Cushman var. **mexicana** Cushman | |
| **crassata** Cushman | Pl. 1, figs. 6, 7 |
| **Lepidocyclina** sp. | Pl. 1, fig. 9 |
| **Heterostegina antillea** Cushman | |

We are figuring several sections of the *Lepidocyclina* forms for reference.

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[1] Instructor, Cornell University

[2] Graduate Student, Cornell University

[3] Cole, W.S., Bull. Am. Pal., vol. 15, No. 57a, pp. 119-122, pl. 17, 1929.

As Vaughan [4] [5] has pointed out, the Meson formation is of Middle Oligocene age, that is, the equivalent of the Antigua formation of Antigua, the Glendon formation of the Gulf States; limestone of Cayman Brac.; Moneague formation of Jamaica.

The small foraminifera also indicate Oligocene age as many of the forms common to the Vicksburg group of the Gulf States are present. They are, however, forms which in general range throughout this group. The following are common to both the Meson formation and the Vicksburg group of the United States:

*Textularia subhauerii* Cushman.
*Clavulina byramensis* Cushman.
*Clavulina byramensis* var. *extans* Cushman.
*Lenticulina convergens* (Bornemann).
*Lenticulina rotulata* (Lamarck).
*Nodosaria longiscata* d'Orbigny
*Guttulina irregularis* (d'Orbigny.)
*Globulina gibba* d'Orbigny.
*Nonion advenus* (Cushman).
*Nonion scaphus* (Fichtel and Moll) var. *mesonensis* n. var.
*Virgulina compressa* (Bailey) *Virgulina* sp. Cushman?
*Uvigerina byramensis* Cushman.
*Discorbis vaughani* Cushman.
*Eponides byramensis* (Cushman).
*Eponides advena* (Cushman).
*Siphonina advena* Cushman.
*Siphoninella byramensis* Cushman.
*Asterigerina subacuta* Cushman.
*Globigerina bulloides* d'Orbigny.
*Cibicides americanus* (Cushman).
*Cibicides lobatulus* (Walker and Jacob).
*Cibicides pseudoungerianus* (Cushman).

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[4] Vaughan, T.W., Bull. Geol. Soc. Am., vol. 35, page 732, 1924
[5] Ibid., Quart. Jour. Geol. Soc., London, vol. 82, p. 391, 1926.

In this paper only four samples will be considered, two of which were collected from the main *Lepidocyclina* zone and two from just above. The two upper samples do not contain any *Lepidocyclina.*

The two Lepidocycline samples (S. C. 1 and 2) are from between km. posts 17-18, the other two (S. C. 3 and 4) from km. posts 18-18.5 on the Aguila Petroleum Company's narrow-gauge railroad between Potrero and Tanhuijo.

The specimens described in this paper are being retained for the present in the personal collection of the senior author.

To Mr. Carroll H. Wègemann, Chief Geologist of the Pan-American Petroleum and Transport Company, the authors acknowledge their indebtedness for permission to publish this paper.

Besides the forms which are described in some detail below, we have found one *Elphidium* which is very close to *E. advenum* (Cushman), a *Vaginulina* very similar to *V. legumen* (Linné), a *Textularia* cf. *T. conica* d'Orbigny and a *Lenticulina* of the type represented by Cushman's figure of *L. crepidula* from the Philippines. As we have only one specimen of each of the above, we are merely noting them for future reference.

## Description of Species

### Order, **FORAMINIFERA**

### Family, **TEXTULARIIDÆ**

### Genus, **TEXTULARIA**, Defrance 1824

**Textularia**, cf. **T gramen** d'Orbigny Pl. 3, fig. 12

**Textularia gramen** d'Orbigny, Foram. Foss. du Bassin Tert. Vienne, 1846, p. 248, pl. 15, figs. 4, 5.

The figured specimen is a young one. Later, we obtained more typical adult forms. These compare rather closely with d'Orbigny's figures.

Sample — S. C. 1, 2.

**Textularia candeiana** d'Orbigny Pl. 2, fig. 11

**Textularia candeiana** d'Orbigny, de la Sagra, Historie Physique, Politique et Naturelle de l'ile de Cuba, 1839, p. 143, pl. 1, figs. 25-27.

**Textularia candeiana** Heron-Allen and Earland, Trans., Zoo, Soc. Lond., vol. 20, pt. 17, 1915, p. 627, pl. 47, figs. 10-16.

There are a few specimens in the Meson which are referable to this species. Heron-Allen and Earland in their recent Foraminifera from the Kerimba Archipelago give a series of forms evidently belonging under one specific name. Most of our forms resemble their figure 14 rather closely. This is small, abbreviated, but has the general shape and arrangement of chambers as in the typical figure of d'Orbigny. The more elongate form does not seem to be present.

Sample — S. C. 2.

**Textularia subhauerii** Cushman

**Textularia subhauerii** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 89, 126, pl. 14, figs. 2a, b.

**Textularia subhauerii** Cushman, Jour. of Pal., vol. 1, 1927, No. 2, p. 148, pl. 23, fig. 2.

The specimens from the Meson resemble Cushman's figure in the Byram Marl paper and also that in the Journal of Paleontology. Both megalospheric and microspheric individuals are present.

Sample — S. C. 1, 2.

### Family, VERNEUILINIDÆ

### Genus, CLAVULINA, d'Orbigny 1826

**Clavulina byramensis** Cushman

**Clavulina byramensis** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 92, pl. 16, fig. 1.

This is a rather abundant species and corresponds very closely to the type.

Sample — S. C. 2.

**Clavulina byramensis** Cushman var. **extans** Cushman Pl. 4, fig. 8

**Clavulina byramensis** Cushman var. **extans** Cushman, U. S. Geol. Survey, Prof. Paper 133, 1923, p. 22, pl. 2, fig. 6.

We have found only two specimens which we consider belonging to this form. They appear to be typical as described by Cushman.

Sample — S. C. 1, 2.

### Family, LAGENIDÆ

### Genus, ROBULUS, Montfort 1808

**Robulus midwayensis** (Plummer) Pl. 2, fig. 12

**Cristellaria midwayensis** Plummer, Univ. Texas, Bull., No. 2644, 1926, pp. 95-96, pl. 13, figs. 5a-c.

We have compared our specimens with specimens in the collection of the senior author which were sent to him through the kindness of Mrs. Plummer. While we believe the Meson form should be referred to the Midway species, the following slight differences were noted. The umbo is not so well developed in our specimens and the ribs over the sutures are not as heavy. This may be due to wear and state of preservation.

Sample — S. C. 1, 2.

### Genus, LENTICULINA, Lamarck 1804

**Lenticulina convergens** Bornemann Pl. 3, fig. 1

**Cristellaria convergens** Bornemann, Zeitschr, deutsch. geol, Ges., vol. 7, 1855, p. 327, pl. 13, figs. 16, 17.

**Cristellaria convergens** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 130.

**Cristellaria convergens** Cushman, U. S. Geol. Survey, Prof. Paper 133, 1923, p. 28, pl. 4, fig. 2.

There are specimens in the Meson which are referable to Bornemann's figure 16. We believe that his figure 17 should be a variety of this species. Specimens previously figured by Cushman from the Vicksburg and from the Alazan agree very closely with our specimens. All of these appear to have much more pronounced sutures and slightly less drawn out final chambers than in the original figure.

Sample — S. C. 1, 2, 3, 4.

**Lenticulina cornellina**, n. sp. Pl. 4, fig. 3

Test small, longer than wide, closely coiled with the exception of the final chamber which is produced; 6-8 chambers compose the last volution; umbilical area covered by a large, rather prominent knob of clear shell material; apertural face of the final chamber rounded; aperture terminal, produced, radiate.

Length, 0.52 mm. Width, 0.29 mm.

This is a very characteristic and easily recognized species with the knob of clear shell material and the final produced chamber. In some specimens this chamber tends to become almost uniserial.

Sample — S. C. 3, 4.

**Lenticulina rotulata** (Lamarck)

**Lenticulites rotulata** Lamarck, Ann. du Muséum, vol. 5, p. 188, No. 3, 1804; vol. 8, 1806, pl. 62, fig. 11.

**Cristellaria rotulata** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 130, pl. 32, fig. 1.

The Meson specimens look exactly like the one figured by Cushman from the Mint Spring Marl.

Sample — S. C. 1, 2.

### Genus, MARGINULINA, d'Orbigny 1826

**Marginulina mesonensis**, n. sp. Pl. 2, fig. 4.

Test elongate, compressed except the initial and final chambers which are slightly inflated, early chambers forming a portion of a coil, later chambers uniserial; sutures depressed, of clearer shell material; chamber walls covered by numerous very fine costae except the final chamber, aperture slightly radiate at the end of a very well developed neck, eccentric on the dorsal side.

Length, 0.55 mm.

Sample — S. C. 3.

This species greatly resembles *M. striatula* Cushman, particularly the one illustrated in the Atlantic fauna. It differs from this in its smaller size, more compressed form and slightly different shape. While the relationship is close, we feel that this species can be distinguished from the recent form.

The costæ are very fine and apparently do not cover the final chamber, which is smooth.

**Marginulina mexicana** Cushman Pl. 2, fig. 7

**Marginulina mexicana** Cushman, Contrib. Cush. Lab. Foram, Res., vol. 1, 1925, pt. 3, p. 61, pl. 10, figs. 1a, b.

This is typical. It is quite distinct from *M. pulchra.* These two forms evidently form two distinct and separate zones within the Meson formation.

Sample — S. C. 1, 2, 3, 4 (more abundant 3, 4.)

### Genus, DENTALINA, d'Orbigny 1826

**Dentalina mesonensis**, n. sp. Pl. 4, fig. 7

Test strongly arcuate, sutures extremely oblique to the axis of the test, about 7 chambers composing the adult test; unornamented chambers; aperture slightly prolonged, radiate.

Length, 1.62 mm.

Sample — S. C. 4.

### Genus, NODOSARIA, Lamarck 1812

**Nodosaria longiscata** d'Orbigny Pl. 4, fig. 1; pl. 3, fig. 9

**Nodosaria longiscata** d'Orbigny, Foram. Foss. du Bassin Tert, Vienne, 1846, p. 32, pl. 1, figs. 10-12.

**Nedosaria ewaldi** Reuss, Zeit. deutsch, geol. Gesel., vol. 3, 1851, p. 58, pl. 3, fig. 2.

**Nodosaria filiformis** Cushman (not d'Orbigny), U. S. Geol. Survey, Prof. Paper 129, 1922, p. 129, pl. 30, figs. 1-3.

**Nodosaria ewaldi** Cushman, Jour. of Pal., vol. 1, 1927, No. 1, p. 153, pl. 24, figs. 1, 2.

**Nodosaria longiscata** Nuttall, Quart, Jour. Geol. Soc., vol. 89, 1928, pt. 1, p. 81, pl. 4, fig. 13.

Various names have been applied to this form, but from a study of our specimens and the various illustrations representing these, we have concluded that there is not enough variation to warrant separate names. Reuss in his description of *ewaldi* claims that it may be distinguished by the more produced aperture. The amount that the aperture is produced is an individual characteristic rather than a specific one.

The Meson forms together with those figured by Cushman from the Vicksburg group have too elongated, cylindrical chambers to permit their being correlated with *N. filiformis* which typically has shorter, more inflated chambers.

Sample — S. C. 2, 3, 4.

### Genus, **LINGULINA**, d'Orbigny 1826

**Lingulina mesonensis** Cole, n. sp. Pl. 1, fig. 3

Test large, compressed, unornamented, chambers about 5 in number, the middle three broad and short, the other two considerably larger and together comprising half the length of the test; sutures depressed; margin bluntly rounded, wavy in outline, entirely without any trace of a keel; aperture a compressed elongated slit, bordered by two slight lips.

Length, 3.9 mm. Width, 2.24 mm.

Sample — S. C. 1 and 2.

This species is comparatively rare in the Meson. It is nearest *L. grandis* Cushman from the Philippines, but that form has a keel and slightly different arrangement of chambers.

## Family, **POLYMORPHINIDÆ**

### Genus, **GUTTULINA**, d'Orbigny 1826

**Guttulina irregularis** (d'Orbigny)

Cushman in his Contributions (vol. 5, pt. 4, p. 89) states that "*Polymorphina byramensis* Cushman" is a synonym of this species. As he is publishing a complete note on this form, we will merely state that our Meson forms are the same as the so-called "*P. byramensis.*"

Sample — S. C. 2.

### Sub-genus, **GLOBULINA**, d'Orbigny 1826

**Globulina gibba** d'Orbigny

**Polymorphina (Globulina) gibba** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 226, No. 20, Modèles, No. 63.

**Polymorphina gibba** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 93, pl. 17, fig. 3.

A few typical specimens were found.

Sample — S. C. 1, 2, 3.

### Family, **NONIONIDÆ**

### Genus, **NONION**, Montfort 1808

**Nonion advenus** (Cushman) Pl. 2, fig. 15

**Nonionina advena** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 139, pl. 32, fig. 8.

Very rare. Cushman reports this form only from the Mint Spring member, however Howe later reported it from the Red Bluff Clay. It probably has a longer range than was at first believed.

Sample — S. C. 2.

**Nonion scaphus** (Fichtel and Moll) var. **mesonensis**, n. var. Pl. 2, fig. 3

Test differing from the typical in the lesser number of chambers in the last volution and the more elongate, embracing shape of the final chambers.

Length, 0.38 mm.

One of the forms figured by Cushman from the Byram Marl belongs under this variety. It is very close to the figures given by Fichtel and Moll, but can be separated from that form on the characters listed above.

Sample — S. C. 1, 2, 3, 4.

### Genus, **ELPHIDIUM**, Montfort 1808

**Elphidium sagrum** (d'Orbigny)

**Polystomella sagra** d'Orbigny, de la Sagra, Histoire Physique Politique et Naturelle de l'ile de Cuba, 1839, p. 77, pl. 5, figs. 13 to 15.

Typical. The last chamber is smooth and the specimens otherwise agree with d'Orbigny's figures and description.

Sample — S. C. 1.

### Family, **BULIMINIDÆ**

### Genus, **BULIMINA**, d'Orbigny 1826

**Bulimina ovata** d'Orbigny Pl. 2, fig. 5

**Bulimina ovata** d'Orbigny, Foram, Foss. du Bassin Tert. Vienne, 1846, p. 185, pl. 11, figs. 13, 14.

The Meson specimens are very close to the species described by d'Orbigny from the Vienna Basin. The chambers of our specimens seem slightly more inflated, but the general arrangement and size seems to warrant our referring it to d'Orbigny's species. The smooth Buliminas are in a very unsatisfactory condition and need more study in order to separate the various ones which have been grouped under the specific name *ovata*.

Sample — S. C. 1, 2, 3.

Genus, **VIRGULINA**, d'Orbigny 1826

**Virgulina compressa** (Bailey) Pl. 2, fig. 8

**Bulimina compressa** Bailey, Smithsonian Contrib., vol. 2, 1851, Art. 3, p. 12, figs. 35-37.

**Virgulina compressa** Cushman, U. S. Nat. Mus., Bull. 104, 1922, p. 116, pl. 24, figs. 2, 3.

This is very similar to the recent forms. The general shape, size and position of the sutures is the same; figure (2) given by Cushman in the Atlantic foraminifera, is an exact duplicate of our specimens.

Sample — S. C. 1, 2, (rare 3, 4).

Genus, **UVIGERINA**, d'Orbigny 1826

**Uvigerina byramensis** Cushman Pl. 2, fig. 6

**Uvigerina byramensis** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 95, 133, pl. 18, fig. 5.

This is one of the most numerous small fossils occurring at this horizon. It follows Cushman's description and compares exactly with specimens in the senior author's collection from the Byram Marl.

Sample — S. C. 1, 2, 3, 4.

**Uvigerina byramensis** Cushman var. **mesonensis**, n. var.

Test differing from the typical in its more compact less elongate form; the uniserial chambers not so pronounced; other characters similar.

Length, 0.37 mm.

Sample — S. C. 1, 2, 3, 4.

Family, **ROTALIIDÆ**

Genus, **DISCORBIS**, Lamarck 1804

**Discorbis subaraucana** Cushman, Pl. 3, figs. 2, 3

**Discorbis subaraucana** Cushman, Carnegie Inst. of Washington, vol. 17, 1922, p. 41, pl. 7, figs. 1, 2.

The fossil specimens are almost exactly like the recent form described by Cushman from the Tortugas region. The only differences noted were that our specimens have a slightly lobate outline and the umbilicus is deeper. The size, position and character of the sutures together with its general features, makes it desirable to refer the Meson specimens to the recent until actual specimens can be compared.

In our figure of this form the artist over-emphasized the umbilical area which is not nearly as prominent in most specimens.

Sample — S. C. 1, 2, 3, 4.

**Discorbis vaughani** Cushman

**Discorbis patelliformis** Cushman (not H. B. Brady), U. S. Geol. Survey, Prof. Paper 133, 1923, p. 38, pl. 6, figs. 3, 4.

**Discorbis vaughani** Cushman, Jour. of Pal., vol. 1, 1927, No. 2, p. 164, pl. 25, figs. 5, 6.

This fossil occurs very rarely in the Meson. Cushman has reported it from the Alazan (Lower Oligocene). It evidently has a very long vertical range.

Genus, **EPONIDES**, Montfort, 1808

**Eponides advena** (Cushman)

**Rotalia advena** Cushman, U. S. Geol. Survey, Prof. Paper 133, 1923, p. 46, pl. 7, figs. 4-6.

This is a rare species in the Meson. It appears to be quite typical with the type as described by Cushman.

**Eponides byramensis** (Cushman) Pl. 2, figs. 1, 2

**Pulvinulina byramensis** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 99, 138, pl. 22, figs. 4, 5.

This is one of the most abundant forms. It is typical and compares exactly with Cushman's original description and figures. It has a wide vertical and horizontal range in both the Vicksburg group and the Meson formation. It is the most abundant species in samples S. C. 3, 4 and less abundant in S. C. 1, 2.

Genus, **SIPHONINA**, Reuss 1849

**Siphonina advena** Cushman Pl. 4, figs. 5, 6

**Siphonina advena** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 98, 137, pl. 22, figs. 1, 2.

This is a common and abundant form in the Meson.

Sample — S. C. 1, 2 very abundant, 3, 4 rare.

Genus, **SIPHONINELLA**, Cushman 1927

**Siphoninella byramensis** Cushman Pl. 3, figs. 4, 5

**Siphoninella byramensis** Cushman, Contrib. Cush. Lab. Foram. Res., vol. 5, 1929, No. 2, p. 46, pl. 8, figs. 5a-c.

This interesting form occurs in some numbers. To date, this form has been only reported from the Byram Marl.

Sample — S. C. 3.

### Family, **AMPHISTEGINIDÆ**

#### Genus, **ASTERIGERINA**, d'Orbigny 1839

**Asterigerina subacuta** Cushman

**Asterigerina subacuta** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 100, pl. 24, figs. 1-3.

A few very poor specimens are referred temporarily to this species.

Sample — S. C. 1.

### Family, **GLOBIGERINIDÆ**

#### Genus, **GLOBIGERINA**, d'Orbigny 1826

**Globigerina apertura** Cushman Pl. 2, fig. 13

**Globigerina apertura** Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 57, pl. 12, fig. 8.

A few *Globigerina* with very large apertures are referred to this species, originally described by Cushman form the Miocene of the United States. The shape of the chambers, together with the large size of the aperture would preclude it from being referred to any other species.

Sample — S. C. 3.

**Globigerina bulloides** d'Orbigny Pl. 2, fig. 16

**Globigerina bulloides** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, No. 1, p. 277, Modèles 17, 76.

**Globigerina bulloides** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 95, 134, pl. 19, figs. 1-3.

There are numerous specimens which may be referred to this species. Our specimens are much like those from the Byram Marl. However, so many different illustrations are given for this form that it is hard to show definitely just how much variation should be allowed.

Sample — S. C. 1, 2, 3, 4.

**Globigerina eocaenica** Terquem Pl. 2, fig. 14

**Globigerina eocaenica** Terquem, Mem. Soc. Geol. de France, ser. 3, vol. 2, 1882, p. 86, pl. 9, fig. 4.

**Globigerina eocaenica** Cole. Bull. Am. Pal., vol. 14, 1928, No. 53, p. 17, pl. 1, fig. 10; pl. 3, fig. 8.

Specimens from the Meson agree very closely with specimens from the Chapapote referred by the senior author previously to this species. The general arrangement of chambers and aperture is exactly as described by Terquem. The umbilical area of our specimen is slightly more prominent.

Sample — S. C. 1, 3, 4.

**Globigerina rubra** d'Orbigny Pl. 2, figs. 9, 10

**Globigerina rubra** d'Orbigny in de la Sagra, Histoire Physique, Politique et Naturelle de l'ile de Cuba, Foraminiféres, 1839, p. 94, pl. 4, figs. 12-14.

There are a few specimens referable to this species. The supplementary apertures are not as pronounced as in d'Orbigny's figures, but this may be due to the filling in fossilization.

Sample — S. C. 1.

### Genus, PULLENIATINA, Cushman 1927

**Pulleniatina obliquiloculata** (Parker and Jones) Pl. 3, figs. 6, 7

**Pullenia obliquiloculata** Parker and Jones, Philos, Trans., vol. 155, 1865, p. 368, pl. 19, figs. 4a, b.

**Pullenia obliquiloculata** Brady, Rept. Voy Challenger, Zoo., vol. 9, 1884, p. 618, pl. 84, figs. 16-20.

Our specimens compare very closely with figures given by other authors, particularly Brady. It is of interest to find this species in the Oligocene in a shallow water deposit. Enough specimens were found to give us a complete series of all ages.

Sample — S. C. 1, 2.

## Family, ANOMALINIDÆ

### Genus, CIBICIDES, Montfort 1808

**Cibicides americanus** (Cushman) Pl. 4, fig. 4

**Truncatulina americana** Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 63, pl. 20, figs. 2, 3; pl. 21, fig. 1.

**Truncatulina americana** Cushman U. S. Nat. Mus. Bull. 103, 1918, p. 68, pl. 23, figs. 2a-c.

**Truncatulina americana** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, p. 97, pl. 20, figs. 7-8.

The placing of this form generically[6] is rather unsatisfactory due primarily to d'Orbigny's original and subsequent descriptions of his genus *Anomalina*. In his first description (Ann. Sci. Nat. 1826) he states *"ouverture lateral en fente,"* in 1839 in the Cuba monograph he is more explicit saying *"ouverture en fente, situeé a la region ombilicale, souvent continuant d'une loge a l'autre"* and still later, 1846, in the Vienna monograph he still modifies his original description so that *Anomalina* is apparently similar to *Truncatulina,* except that *Anomalina* is free and has no spire. *Cibicides* because of its attached mode has modified its test from that of *Anomalina.*

Our form was evidently attached at least for part of its life, but a spire has not been developed. It is evident that this is an intermediate stage between the true *Anomalina* and *Cibicides.*

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[6] Much of the material in this discussion was taken from a personal communication to the senior author by Dr. Cushman. The original literature was also consulted.

Because of its apparent mode of life and modification toward the *Cibicides* form, we prefer to classify it with *Cibicides*.

While Cushman used the specific name *americana* to describe both a species in his Coastal Plain Paper and also in his Panama Papers, it seems to us that all these forms are similar enough to be placed under one specific name than to create a new name for the Oligocene forms.

Sample — S. C. 1, 2, 3, 4.

**Cibicides elongatus** (d'Orbigny) Pl. 3, fig. 8; pl. 4, fig. 9

**Truncatulina elongata** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, No. 2, p. 279.

**Truncatulina elongata** Terquem, Mém. Soc. Geol. de France, ser. 3, vol. 2, 1882, pp. 93, 94, pl. 17, figs. 26a, b.

There are some specimens which we are placing under this specific name. Some of our specimens agree exactly with the figures given by Terquem; some are more irregular. These forms, however, may not constitute a separate species, but represent a degenerate form of *C. lobatulus.* There appears to be some gradational specimens between the two extremes. For the present, until a more perfect connection between the two can be made, we are using both names.

Sample — S. C. 1 (abundant), 3, 4, (very rare.)

**Cibicides lobatulus** (Walker and Jacob) Pl. 4, fig. 2

**Nautilus lobatulus** Walker and Jacob, Adams Essays on the microscope, Kanmacher's ed. 1798, p. 642, pl. 14, fig. 36.

**Truncatulina lobatula** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 96, 135, pl. 20, figs. 1-3.

As Cushman has already pointed out, the forms referred by him to this species are not all typical. Our specimens, however, agree very closely with his descriptions and figures of similar forms from the Vicksburg group.

Sample — S. C. 1, 2 (abundant), 3, 4 (rare).

**Cibicides pseudoungerianus** (Cushman) Pl. 3 figs. 10, 11

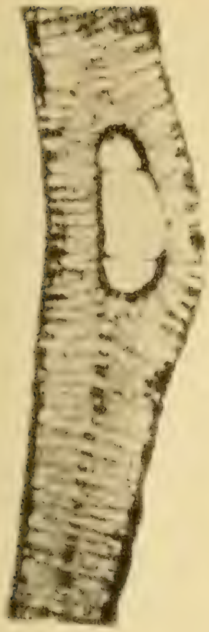
**Truncatulina pseudoungeriana** Cushman, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 97, 136, pl. 20, fig. 9.

While most of our specimens are smaller than those which we have seen from the Byram Marl, they present the same characters generally assigned to this form. For the present, we are referring our specimens to this species, although they may represent a variety.

Sample — S. C. 1, 2, 3, 4

## PLATE 1

1. **L. (Nephrolepidina) undosa** Cushman; vertical section; X 10 3
2. **L. (Nephrolepidina) undosa** Cushman; horizontal section; X 10 3
3. **Lingulina mesonensis** Cole, n. sp.; holotype; X 10 9
4. **L. (Lepidocyclina) parvula** Cushman; vertical section; X 20 3
5. **L. (Lepidocyclina) parvula** Cushman; horizontal section; X 20 3
6. **L. (Nephrolepidina) crassata** Cushman; vertical section of a young specimen; X 10 3
7. **L. (Nephrolepidina) crassata** Cushman; vertical section; X 10 3
8. **L. (Neprolepidina) gigas** Cushman; horizontal section; X 10 3
9. **Lepidocyclina** sp.; vertical section; X 10 3



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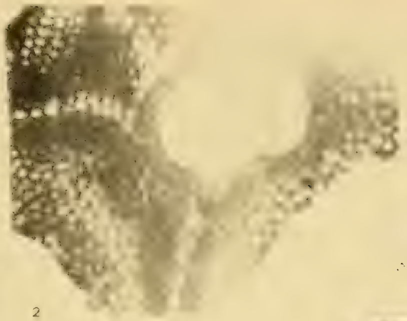

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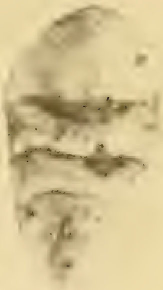

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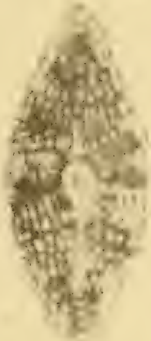

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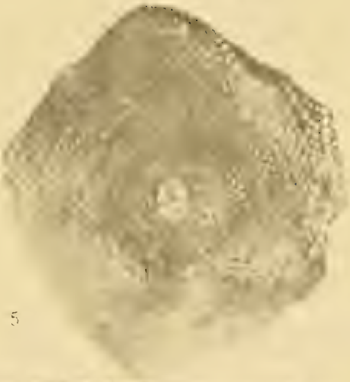

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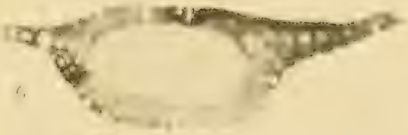

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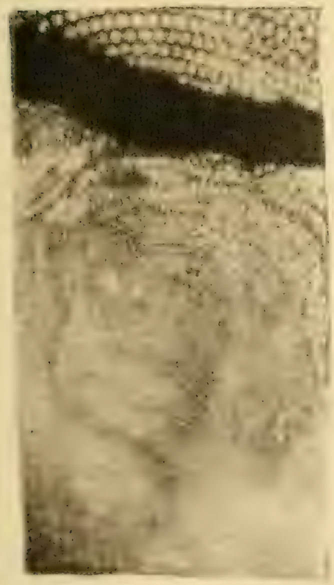

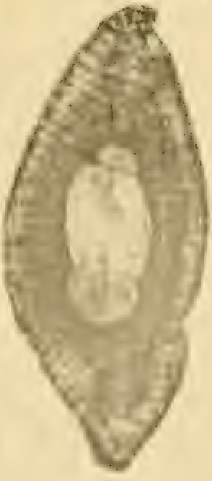

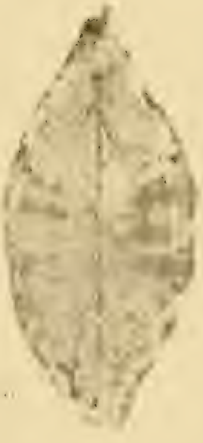

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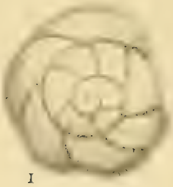

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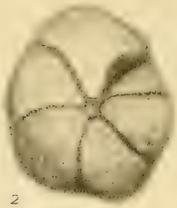

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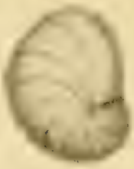

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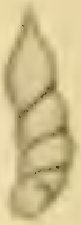

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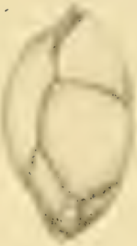

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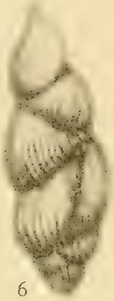

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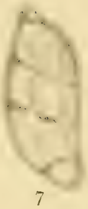

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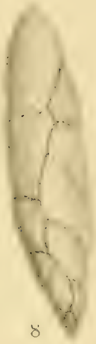

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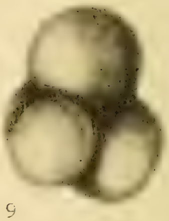

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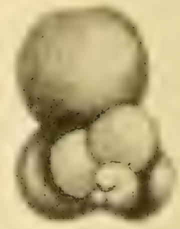

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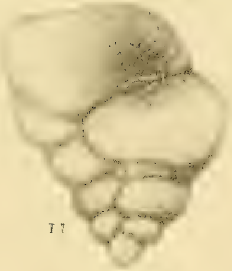

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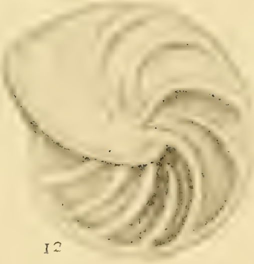

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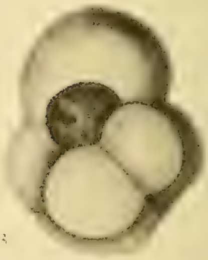

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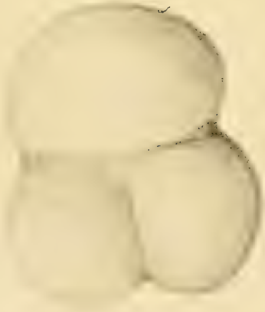

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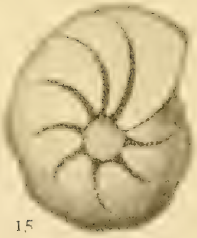

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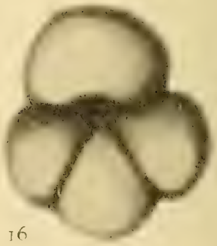

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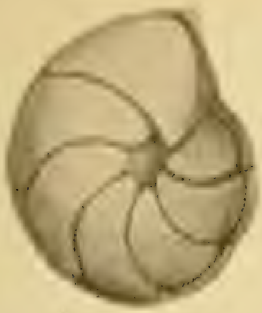
## PLATE 2

| | | |
|---|---|---|
| 1. | **Eponides byramensis** (Cushman); dorsal view; X 50 | 12 |
| 2. | **Eponides byramensis** (Cushman); vertical view; X 50 | 12 |
| 3. | **Nonion scaphus** (Fichtel and Moll) var. **mesonensis,** n. var.; side view; holotype; X 55 | 10 |
| 4. | **Marginulina mesonensis** n. sp.; side view; holotype X 50 | 8 |
| 5. | **Bulimina ovata** d'Orbigny; X 85 | 10 |
| 6. | **Uvigerina byramensis;** X 85 | 11 |
| 7. | **Marginulina mexicana** Cushman; side view of a very young specimen; X 50 | 8 |
| 8. | **Virgulina compressa** (Bailey); X 85 | 11 |
| 9. | **Globigerina rubra** d'Orbigny; ventral view; X 85 | 14 |
| 10. | **Globigerina rubra** d'Orbigny; dorsal view; X 85 | 14 |
| 11. | **Textularia candeiana** d'Orbigny ; X 85 | 5 |
| 12. | **Robulus midweyensis** (Plummer); side view; X 30 | 6 |
| 13. | **Globigerina apertura** Cushman; ventral view; X 85 | 13 |
| 14. | **Globigerina eocaenica** Terquem; ventral view; X 85 | 13 |
| 15. | **Nonion advenus** (Cushman); side view; X 85 | 10 |
| 16. | **Globigerina bulloides** d'Orbigny; ventral view; X 85 | 13 |

## PLATE 3

| Fig. | | Page |
|---|---|---|
| 1. | **Lenticulina convergens** (Bornemann); side view; X 85 | 7 |
| 2. | **Discorbis subaraucana** (Cushman); dorsal view; X 85 | 11 |
| 3. | **Discorbis subaraucana** (Cushman); ventral view; X 85 | 11 |
| 4. | **Siphoninella byramensis** Cushman; ventral view; X 85 | 12 |
| 5. | **Siphoninella byramensis** Cushman; dorsal view; X 85 | 12 |
| 6. | **Pulleniatina obliquiloculata** (Parker and Jones); adult specimens; 85 | 14 |
| 7. | **Pulleniatina obliquiloculata** (Parker and Jones); very young specimen; X 85 | 14 |
| 8. | **Cibicides elongatus** (d'Orbigny); ventral view of small specimen; X 85 | 15 |
| 9. | **Nodosaria longiscata** d'Orbigny; X 55 | 8 |
| 10. | **Cibicides pseudoungerianus** (Cushman); dorsal view; X 85 | 15 |
| 11. | **Cibicides pseudoungerianus** (Cushman); ventral view; X 85 | 15 |
| 12. | **Textularia cf. T. gramen** d'Orbigny; X 85 | 5 |



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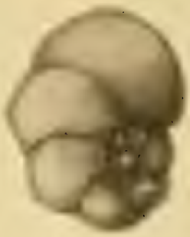

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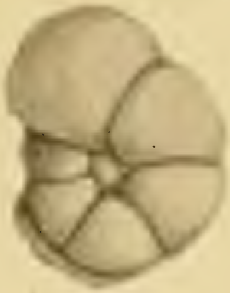

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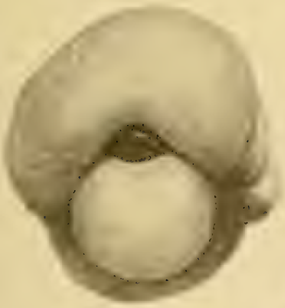

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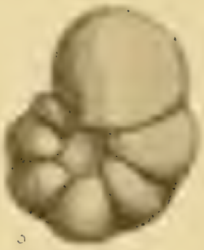

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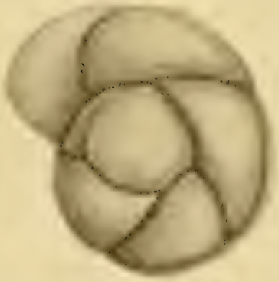

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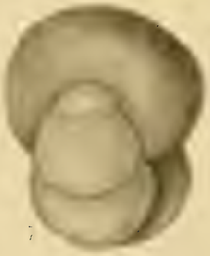

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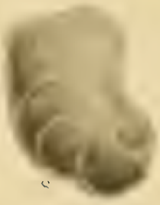

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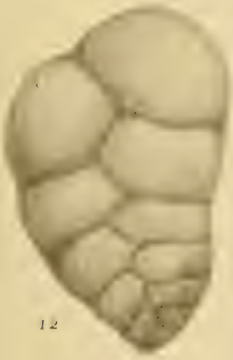

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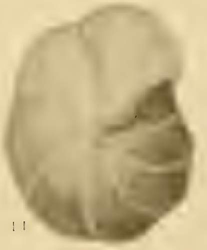

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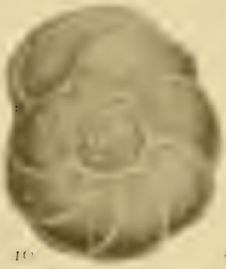

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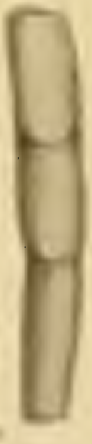

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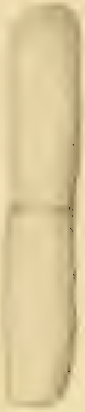
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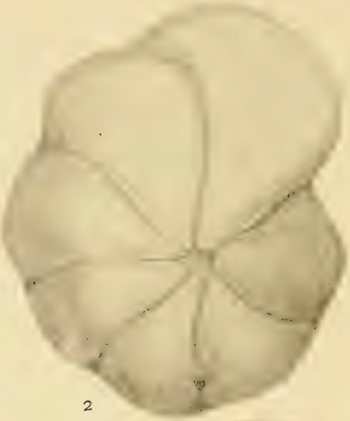
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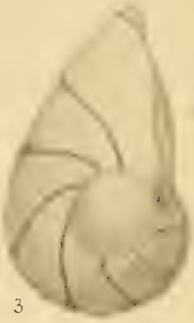
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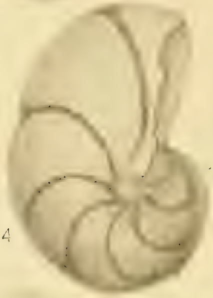
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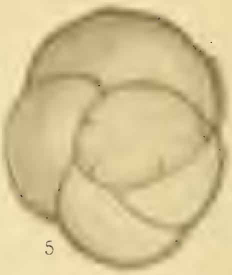
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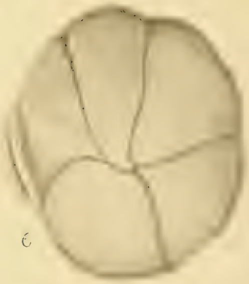
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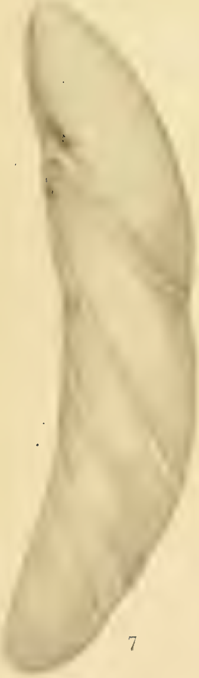
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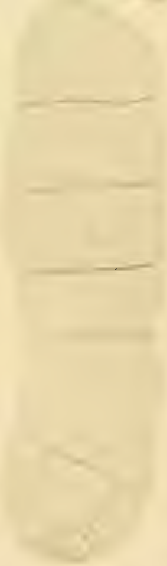
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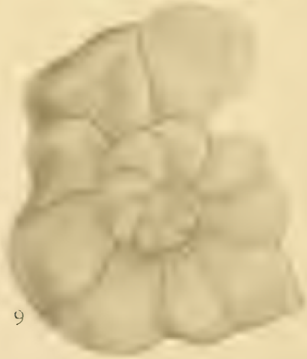
9

## PLATE 4

| | |
|---|---|
| 1. **Nodosaria longiscata** d'Orbigny; X 55 | 8 |
| 2. **Cibicides lobatulus** (Walker and Jacob); ventral view; X 85 | 15 |
| 3. **Lenticulina cornellina** n. sp., side view; holotype; X 85 | 7 |
| 4. **Cibicides americanus** (Cushman); dorsal view; X 85 | 14 |
| 5. **Siphonina advena** Cushman; dorsal view; X 85 | 12 |
| 6. **Siphonina advena** Cushman; ventral view; X 85 | 12 |
| 7. **Dentalina mesonensis** n. sp.; holotype; X 85 | 8 |
| 8. **Clavulina byramensis** var. **extans.** Cushman; outline; X 30 | 6 |
| 9. **Cibicides elongatus** (d'Orbigny); dorsal view; X 85 | 15 |

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# Higher Fossil Faunas of the Upper Allegheny

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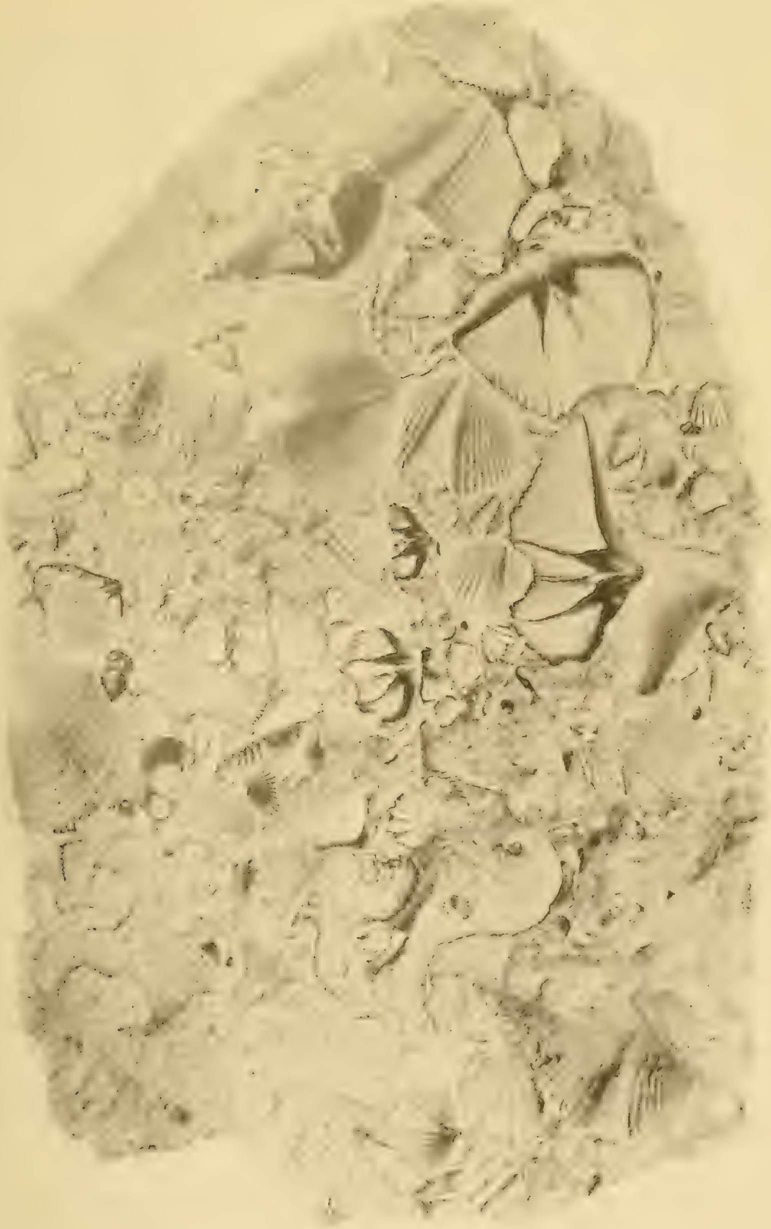
*July 28, 1930*

Harris Co.,
Ithaca, N. Y.
U. S. A.



Slab of Mississippian sandstone from Stone Hill, near Warren, Pennsylvania. This is the fossiliferous 'Venango First Oil sand' horizon. Photo natural size.

# PREFACE

The paramount aim of this paper is to bring together, with some completeness, illustrations of the rich fauna of the upper Devonian and lower Carboniferous strata in the northwestern part of Pennsylvania and the southwestern part of New York. Several new forms are described and the majority of the more common species have been carefully studied both from original material and from specimens in the Cornell University Museum.

This work in no way pretends to be a monograph of the region, which is really very poorly explored from a paleontological view point, the many described species notwithstanding. It is hoped that the plates accompanying the paper will afford a ready means of identification both in the field and laboratory, although the original dissertation must frequently be consulted for a detailed description.

The paleontologic and stratigraphic work in this region is only nicely commenced, and much must yet be done before its past history is satisfactorily explained, especially in its relation to that of surrounding regions. Only by most painstaking paleontologic study will the problem of the Carboniferous-Devonian boundaries for this region be solved. One of the real difficulties of casual study of the faunas of this region is the existence of an extreme range of variation in many of the more common species. The determination of both the horizontal and vertical extent of these minor variations would seem to be the next logical step in the progress of our knowledge.

The stratigraphy of this paper is fundamentally based on the work of professors, Hall, Harris, Butts, Glenn, Clarke, Verwiebe, Girty, and Chadwick. The last named is at present carrying on the work, started some years ago, of unravelling and clarifying the stratigraphy of this region. While in some instances the exact named correlate of beds from which fossils have been obtained is not determined in this paper an attempt has been made in all instances to give the exact locality so far as is known, and the probable horizon is intimated. Many of the specimens described in the early volumes of the Paleontology of New York are called Chemung species when in reality they belong to what we now know as Conewango, Oswayo, or even in some instances, to Mississippian horizons.

The specific description of already described species is usually abridged from the work of the original describer. To this any apparently essential remarks are added. In many instances the illustrations seem to be sufficient characterization for the species.

In a work of this nature it is felt unnecessary to give other than the most essential references under the specific synonymy. It is also felt that elaborate systematic headings are best suited to true monographs and that elsewhere they only encumber the literature.

All original material used in the preparation of this paper is in the paleontological collection of Cornell University. This material is made up of specimens collected by Prof. H. S. Williams, collections of Prof. G. D. Harris, of students at the Cornell Summer School of Geology at Stoneham, Pa., and of the writer.

The writer acknowledges with gratitude the kindness of Dr. Rudolf Ruedemann in examining specimens and permitting him to study many of James Hall's type specimens from the New York State Museum, at Albany, N. Y.

To Professor G. D. Harris, teacher, advisor and friend, the writer is especially grateful for both enthusiastic encouragement and constant suggestions in field and laboratory. It is now through his kindness that this paper is published.

*Paleontology Laboratory*
*Cornell University*
JUNE 15, 1929.

## BRACHIOPODA

### LINGULA

**Lingula scutella** Hall Plate 10, fig. 25.

Pal. of N. Y. VIII, I, 1892, p. 171, pl. 1, fig. 30.

*Occurrence.*—In the Chemung group of Alleghany county, N. Y.

*Note*—In the arenaceous brown shale along the Roosevelt Highway at the northern border of Smethport, Pa., there are many fragments of Lingulas of various sizes. Some of these fragments probably belong to this species.

**Lingula cuyahoga Hall** Plate 10, figs. 13, 15.

Pal. of N. Y. IV, 1867, p. 12, pl. 2, fig. 9.

*Occurrence.*—First described from the Waverly sandstone of Ohio and specimens referred to this species with doubt were found by Hall and Clarke in the Panama conglomerate.

**Lingula delia Hall** Plate 10, fig. 19

Pal. of N. Y. IV, 1867, p. 12, pl. 2, fig. 9.

This is typically a Hamilton *Lingula* but has been reported by Carll and Randall from the Chemung group at Warren, Pa., according to P. Lesley. (Dict. of Fossils, I, p. 344.)

**Lingula ligea Hall** Plate 10, figs. 14, 16.

Pal. of N. Y. IV, 1867, p. 7, pl. 1, fig. 2.

This, like the preceding species, is characteristic of the Hamilton shales but has been reported by Carll from the "Chemung upper strata."

**Lingula waverliensis Herrick** Plate 10, fig. 28.

Bull. Dennison Univ. IV, pt. I, 1888, p. 18, pl. III, fig. 1.

This form is especially interesting due to the preservation of the pedicle with the shell. It was found in the "Waverly sandstone" at Oil City, Pa.

### LINGULODISCINA

**Lingulodiscina pleurites (Meek)** Plate 10, figs. 21-23.

**Discina (Orbiculoidea?) pleurites** Meek, Pal. of Ohio, II, 1875, p. 278, pl. 14, fig. 2.

*Occurrence.*—Recorded from the Wolf Creek Conglomerate in the Olean region, by Mr. C. Butts. (Bull. N. Y. S. Mus. No. 69, p. 993.)

This species was originally described from the Waverly sandstone of Ohio. It has subsequently been reported from the Bedford shales of Ohio by G. Girty[1] and from the Wolf Creek conglomerate of the Olean quadrangle by C. Butts[2].

### ORBICULOIDEA

**Orbiculoidea allegania (Hall)** Plate 10, figs. 24, 26, 27.

**Discina allegania** Hall, Pal. of N. Y., IV, 1867, p. 25, fig. 1, pl. 1, fig. 17.

This is a very large species which bears very fine striæ and is marginally flattened. The apex is a little more than one third of the diameter of the shell from the posterior.

*Occurrence.*—In the Chemung group at Hobbieville, Alleghany county, N. Y.

**Orbiculoidea** Sp.

Fragments of *Orbiculodiea* are the most characteristic feature of small, discontinuous layers of coarse sandy shale in the rocks which are exposed at the northern outskirts of Smethport, Pa., on the Roosevelt Highway. These layers are seldom more than two inches in thickness and none have been observed extending for more than a few feet.

In the Oswayo beds as exposed about two miles west of Smethport, Pa., in a cut along a spur railroad near an abandoned mill, once used for crushing the conglomerate, Orbiculoideas are common. The specimens are all badly crumpled and broken, yet, from these it is evident that the living specimen was very large. The surface is ornamented by very coarse concentric striæ (which are impressed on the mold) spaced about .75 mm. apart. Between these there are many microscopic striæ. Although this species is quite probably undescribed the quality of the material at hand does not warrant a specific description.

## CRANIA

**Crania leoni Hall** Plate 10, figs. 17, 18, 20, 28, 29.

Pal. of N. Y. vol. IV, 1867, p. 30, pl. 3, figs. 27-30.

*Occurrence.*—In the Chemung beds at Leon, Cattaraugus county, N. Y. We have also found specimens, temporarily referred to this species, in the Oswayo beds near Olean Rock City, N. Y.

## SCHUCHERTELLA

**Schuchertella chemungensis** (Conrad) Plate 15, figs. 1-3, 5, 6, 8.

**Streptorhynchus chemungensis** (Hall) Pal. of N. Y. vol. IV, 1887, p. 67.
**Streptorhynchus chemungensis** var. **pectinacea** Hall, Pal. of N. Y. vol. IV, 1867, p. 73, pl. 10, fig. 6.

*Occurrence.*—Originally described by Conrad from material collected at Chemung Narrows. Reported by Ashburner from over the Salamanca Conglomerate and by Lesley, in the Dictionary of Fossils, p. 1090, from the Panama conglomerate. We have also collected specimens of this species well preserved in the Panama conglomerate at Checkered School House, near Ashville, N. Y.

## ORTHOTHETES

**Orthothetes crenistria** (Phillips?) Plate 16, figs. 1, 2.

**Hemipronites crenistria**, Herrick, Bull. Dennison Univ. vol. IV, 1888, p. 24, pl. 2, figs. 1, 5.

**Orthothetes crenistria** Hall and Clarke, Pal. of N. Y. vol. VIII, I, 1892, pl. 11a, fig. 15.

*Occurrence.*—In the Waverly sandstones of Ohio. Reported by Mr. C. Butts from the beds between the Wolf Creek and the Salamanca conglomerates.

[1] Girty, G. H., Ann. N. Y. Acad. Sc. vol. 22, 1912, p. 295.
[2] Butts, C., N. Y. S. Mus. Bull. No. 69, p. 994.

## STROPHALOSIA

**Strophalosia histricula** (Hall) Plate 20, figs 15-20.

**Productella histricula** Hall, Pal. of N. Y. IV, 1867, p. 178, pl. 26, figs. 1-8.

*Occurrence.*—According to J. Hall, this species is very common in a hard arenaceous shale at Forestville, N. Y., and in a friable sandstone at Conewango, and in semi-calcareous layers at East Randolph, N. Y. Specimens possibly referable to this species are commonly found in a yellowish sandstone of the Venango First Oil Sand horizon one mile east of Stoneham, Pa.

**Strophalosia muricata** (Hall) Plate 16, figs. 3-8.

**Chonetes muricata** Hall, Pal. of N. Y. IV, 1867, p. 143, pl. 22, figs. 29-43.

*Occurrence.*—In the arenaceous and semi-calcareous beds of the 'Chemung group' at Ellington, Chautauqua county, N. Y., and at Meadville, Pa.

## CHONETES

**Chonetes lepidus** Hall Plate 16, fig. 10.

Pal. of N. Y. IV, 1867, p. 142, pl. 22, figs. 12, 13.

*Occurrence.*—In the Marcellus shales and in the Chemung beds at Great Valley, Forestville, Chautauqua county, N. Y., and rarely at Meadville, Pa.

**Chonetes scitulus** Hall Plate 16, figs. 9, 11-13.

Pal. of N. Y. IV, 1867, p. 141, pl. 21, fig. 4.

*Occurrence.*—In the Portage and lower Chemung shales and in the upper Chemung at Grass Valley and Conewango in Cattaraugus county, N. Y., in Chautauqua county and at Meadville, Pa. This species is reported by Prosser (Geol. Surv. of

Ohio. Bull. 15, p. 97) from the Riceville shales of Ohio and from the Bedford shales of Ohio by Herrick (Am. Geol. III, p. 97.)

**Chonetes setigerus** (Hall) Plate 16, figs. 14-17.

Pal. of N. Y. IV, 1867, p. 129, pl. 21, fig. 2; pl. 22, figs. 1-5.

*Occurrence.*—In the Genessee and Marcellus shales and in the Chemung group at Meadville, Pa.

### RHIPIDOMELLA

**Rhipidomella leucosia** (Hall) Plate 16, figs. 19, 22.

**Orthis leucosia** Hall, Pal. of N. Y. IV, 1867, pp. 48, 63, pl. 7, fig. 4; pl. 8, figs. 9, 10.

*Occurrence.*—This is characteristically a Hamilton species but forms referred to this species have been reported by J. Hall and Randall from the Chemung beds of northwestern Pa.

**Rhipidomella pennsylvanica** (Simpson) Plate 17 figs. 9, 10.

**Orthis pennsylvanica** Simpson, Tr. Am. Phil. Soc. n. s. 16, 1889, p. 437.

According to Simpson, "This species may be distinguished from *Schizophoria striatula* of the same formation, by its smaller size and more circular outline; from *Schizophoria tioga* by its more circular outline, less conspicuous mesial sinus and elevation, and oval muscular impression."

*Occurrence.*—In the Chemung group of Tioga county; on the P. and E. railroad between Ludlow and Wetmore, and in Kinzua Creek near the western line of McKean county, Pa., and 'elsewhere in Pa.'

### DALMANELLA

**Dalmanella tenuilineata** (Hall) Plate 11, figs. 13, 14.

**Orthis leonensis** Hall, Pal. of N. Y. IV, 1867, p. 62, pl. 8, figs. 3-8.

The dorsal valve has a distinct longitudinal sinus and has the base more or less abruptly truncated in the middle. The ventral valve may be slightly elevated along the median line. The muscular impression is oval or ovate and somewhat visibly lobed. The area is shorter than the width of the shell. The surface striæ are strong. Specimens of this species are usually small.—*Hall.*

*Occurrence.*—In the arenaceous beds of the Chemung group near Leon, Conewango, and Randolph, N. Y.

**Dalmanella tioga** (Hall) Plate 17, figs. 1-4, 6, 12.

**Orthis tioga** Hall, Pal. of N. Y. IV, 1867, p. 59, pl. 8, figs. 20-29.

Shell transversely elliptical; dorsal valve with a well marked sinus; ventral valve sometimes with a mesial elevation; foramen wide. Striæ angular and curving upward at the hingeline. Every second stria on the upper part of the shell and every third or fourth on the lower part seem to be strongest. The shell structure is minutely punctate. Dorsal muscular impression indistinct; strong cardinal process present and bilobed apically. Ventral muscular impression sub-pentagonal and deeply bilobed below.

*Occurrence.*—Common in Chemung at Tioga, Pa., and also in Alleghany and Cattaraugus counties, N. Y.

### STROPHEODONTA

**Stropheodonta demissa** (Conrad) Plate 15, figs. 4, 7.

Pal. of N. Y. IV, 1867, p. 81, pl. 11, figs. 14-17; pl. 12, figs. 1-5.

*Occurrence.*—In the middle and upper Chemung groups of New York and Pa. It is very common in Cattaraugus and Chautauqua counties, N. Y.

### SCHIZOPHORIA

**Schizophoria striatula** (Schlotheim) Plate 17, figs. 5, 7, 8, 11, 15, 16.

**Orthis impressa** Hall, Pal. of N. Y. IV, 1867, p. 60, pl. 8, figs. 11-19.

The surface bears delicate radial striæ and the shell structure is punctate. The dorsal muscular impression is quadrilobate, and limited by widely diverging dental plates. Narrow vascular impressions extend below the muscular scar to the margin of the shell. The ventral valve is broadly sinuate in the middle. The muscular impression is triangular or sub-ovate and deeply bilobed. The general size and shape of this impression is extremely variable.

*Occurrence.*—A common Chemung species. Found frequently in western N. Y. and Pa.

### CAMAROTŒCHIA

This genus is characterized by its rostrate rhynchonelloid appearance and its usual trihedral outline. The pedicle valve is usually shallow and the brachial more or less convex. The surface is radially plicated with a varying number of angular or subangular (sometimes rounded) plications. The brachial valve bears internally a medial septum which is posteriorly divided forming an elongate spondylium. Each division of the septum supports one of the lateral divisions of the hinge plate, to which are attached the curved crural processes. There is no cardinal process. In the genotype *C. congregata* (Con.), the dental sockets are crenulate.

Due to the similarity of external characters in the different species of *Camarotœchia,* the dissimilarity of the various stages of growth of the same species, and the tendency to deviate from the mean of any specific characterization, the exact taxonomic classification of many forms is often obscure.

From the Chadokoin and Conewango several hundred specimens of this genus have been collected. A good portion of these have been referred to *C. contracta* (Hall), an almost equal number to *C. sappho* (Hall). We refer *C. orbicularis* (Hall) to synonymy under the discussion of *C. sappho.* A few specimens are being referred to *C. eximia* (Hall) but when more and better material has been collected these forms may be assigned to other species. From the Oswayo member we have a fair collection of *C. allegania* (Wms.). They are in the usual poorly preserved condition, i. e., molds and casts.

**Camarotœchia contracta** (Hall) Plate 12, figs. 1-2, 4-6, 11.

**Atrypa contracta** Hall, Geol. Rpt. Fourth Dist. N. Y. G. S. 1843, tb. 66, pl. 53, figs. 26-39.

**Rhynchonella (Stenocisma) contracta** (Hall) Pal. N. Y. IV, 1867, p. 351, pl. 55, figs. 26-39.

**Rhynchonalla contracta,** Herrick, Bul. Dennison Univ. III, 1887, p. 39, pl. 10, fig. 9; IV, p. 23, pl. 11.

**Camarotœchia contracta,** Hall and Clark, Pal. N. Y. VIII, pt. II, 1893 p. 192, pl. 57, figs. 28, 32, 49.

**Camarotœchia contracta,** Raymond, Ann. Carn. Mus. V, 1908, p. 141.

**Camarotœchia contracta** (Hall) Md. Geol. Surv. Upper Devonian, 1913, p. 577, pl. 53.

**Camarotœchia** aff. **contracta,** Girty, U. S. G. S. Prof. Paper No. 150 E, 1927, p. 117.

In the original description of *C. contracta* (Pal. N. Y. IV, 1867, p. 351) James Hall describes this species as having a gibbous dorsal valve, which is highest in the middle, and regularly convex transversely. The surface is marked by about sixteen angular plications. This number may vary from sixteen to twenty. Of these, three are in the mesial sinus and four on the mesial fold. The plications on the fold originate from the posterior bifurcation of two mesial ones near the apex of the beak.

The two central ribs are larger than the two lateral ones. The boundary plications on the fold and sinus have especially broad inner slopes. The sinus is produced anteriorly in a linguiform extension.

Hall says also, in his original description, that the younger specimens may have but one or two plications in the sinus and a corresponding number on the fold. Other specimens of ordinary size have four plications in the sinus and five on the fold. In some specimens with very angular plications there are only five or six on each side of the fold and sinus.

The outline of the shell varies from subquadrate to ovate, or almost triangular. The anterior margin is usually broadly oval.

This species is very common in the Chemung and Conewango horizons and has been reported from the Waverly of Ohio[3] and doubtfully from the Pocono of Pennsylvania by Mr. G. H. Girty[4].

The dimensions of our specimen vary between 9 mm. in width and 8 mm. in length and 21 mm. in width and 19 mm. in length. The average dimensions of the species are about 17 mm. in width and 15 mm. in length.

The central ribs curve gently to the front and likewise the lateral ones. None bend abruptly to the sides. On about three hundred specimens examined the total count of ribs vary thus:

| | | | | |
|---|---|---|---|---|
| 92 | specimens | with | 20 | plications |
| 107 | ” | ” | 18 | ” |
| 89 | ” | ” | 16 | ” |
| 4 | ” | ” | 15 | ” |
| 4 | ” | ” | 14 | ” |
| 2 | ” | ” | 21 | ” |
| 6 | ” | ” | 22 | ” |

The plications on the mesial fold and in the sinus vary as follows (The arrangement (1-2) means that there is one rib in the sinus and there are two on the fold):

---

[3] Pal. N. Y. IV, 1867, p. 351.

[4] U. S. G. S. Prof. Paper 150 E. 1927, p. 117.

3 specimens with a ( 1-2 ) mesial arrangement of ribs
189 " " " ( 2-3 ) " " " "
177 " " " ( 3-4 ) " " " "

This material comes from the following localities in southwestern New York and northwestern Pennsylvania. The horizons are for the most part from the Conewango[5] (Cattaraugus[6] and Oswayo[7]) of the Bradfordian series[8].

Pope Hollow, Chautauqua county, N. Y., Ptychopteria zone about 50-70 feet below the conglomerate at that place[9] in the Cattaraugus beds, yields many specimens. The measurements of typical specimens from this station are: 12 to 22 mm. wide, and 12 to 17.5 mm. long. The ribs number from 16 to 18, those on the center are mostly of the ( 2-3 ) arrangement and a few of ( 3-4 ) type.

One mile east of Stoneham, Pa., and about three miles southeast of Warren, Pa., in the Conewango near the contact of the "Cuyahoga" of Verwiebe[10] and the Sub-Olean. This zone also contains *Ptychopteria* but by no means as plentifully as the Pope Hollow locality. The width of specimens of a ( 2-3 ) median plication arrangement varied between 12 and 22 mm. and the length between 7 and 15 mm. Those specimens with (3-4) arrangement were 9 to 23 mm. wide and 8 to 17 mm. long. Some of the specimens are very flat and apparently naturally so. Several specimens have a very deep sinus which is abruptly bent upward and have a much elevated fold on which the plications are very well developed. The ( 3-4 ) mesial arrangement of ribs is the most common. The variation in the total number of ribs is as follows:

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[5] Girty, G. H., U. S. G. S. Folio No. 172, p. 4.
[6] Glenn, L. C., N. Y. S. Mus. Bul. No. 69, pp. 971-978.
[7] Ibid.
[8] Girty, Science, XIX, 1904, p. 4.
[9] Harris, G. D., Am. Geol., Mar. 1891, p. 164.
[10] Am. J. Sc. XLIII, 1917, p. 309.

| | | | | |
|---|---|---|---|---|
| 1 | specimen | with | 21 | plications |
| 6 | ” | ” | 16 | ” |
| 36 | ” | ” | 20 | ” |
| 41 | ” | ” | 18 | ” |
| 4 | ” | ” | 14 | ” |
| 3 | ” | ” | 15 | ” |

Stone Hill, one mile northeast of Stoneham, Pa. The specimens come from a very fossilferous stratum of the Conewango[11]. The specimens have for the most part 16 or 17 plications with medially (3-4).

Kinzua, Pa., 25 feet above the river. Bradfordian forms, rather poorly preserved.

Two miles northwest of Warren in Conewango the specimens were as follows:

Width varying from 20 to 22 mms.

Length varying from 17 to 20 mms.

Plications varying from 18 to 20, with 3 in sinus and 4 on the fold.

**Camarotœchia allegania** (Williams) Plate 14, figs. 1-2, 4-5.

**Rhynchonella allegania** Williams, U. S. G. S. Bul. No. 41, 1887, p. 87, pl. IV.

**Camarotæchia allegania** (Williams), Butts, Report N. Y. State Mus. No. 69, 1903, p. 994.

*Camarotœchia allegania* is in general appearance very similar to *C. sappho* (Hall). It has a large, broad shell, the ventral valve of which has a rather flat sinus and the dorsal valve a correspondingly flat fold. The fold and sinus bear from five to seven well defined rounded plications. Under the beak of the ventral valve there is a "broad flat tongue-like platform, representing a depression in the shell itself"[12]. It was noted in the original description that the cardinal teeth bear conspicuous serrations. The dorsal valve bears a short and strong median septum. The beak of the ventral valve is elongate and rounded and perforated at the extremity. There are from twenty to twenty-six plications.

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[11] This is the Berea of Girty (Ann. N. Y. Acad. Sc. XXII, 1912, pp. 295-319.) and the Venango First Sandstone of Verwiebe (Am. J. Sc. XLIII, 1917, p. 306.

[12] U. S. G. S. Bul. No. 41, 1887, p. 87.

This species was described from the ferruginous sandstones of the Little Genessee Rock City, N. Y. Williams mentions in the original description that *C. allegania* is closest related to *C. orbicularis* (Hall) or some variety of *C. sappho* (Hall) and it compared exactly with figures of *C. sageriana* (A Winchell) though it differed from the written description of that species.

In most instances the representatives of this species are in the form of rather badly crumpled casts or molds. The crumpled condition seems to point them out as thinner shelled forms than their associated rhynchonelloid kind. But they may have been littoral forms and wave action caused the crumpled condition. The fact that they are found almost exclusively in the coarse quartzitic sandstone of the upper Conewango would rather substantiate this view.

The most outstanding feaure of these shells, separating them from *C. sappho* (Hall) is the large platform-like muscular imprint on the internal mold of the pedicle valve. This is often much elevated and in some specimens occupies a large portion of the surface of the mold. The opening of the apex of the pedicle valve and the elongate condition of that apex are also characteristic.

*Localities.*—Upper beds of the Conewango (Oswayc?) at Kinzua, Pa.; the same horizon between Kinzua and Bradford, Pa.; Knapp's Creek horizon (Oswayo) at Flat Iron, near Olean Rock City, N. Y.; strata underlying the conglomerate on a hill by the main highway just east of Stickley, Pa.; the same horizon about half way between Stickley and Bradford, Pa.; the Oswayo at Glade, Warren county, Pa.; loose material near the base of the conglomerate on the hills south of Smethport, McKean county, Pa.; near the top of the Oswayo, two miles west of Smethport, Pa., in a railroad cut on the spur line at that place.

**Retzia** (?) sp. Plate 11, figs. 7-12

In the 'Venango First sandstone'[13] one mile east of Stoneham, Pa., and at Stone Hill an abundance of a small rhynchonelloid brachiopod is found. The material is in the form of casts and molds. The general features are those of the Retzidæ and of the genera *Retzia, Homeospira* or *Rhynchospirina.* The internal characters are practically unknown from this material. The figures on Plate 11 and the Frontispiece show the forms as known from these two localities.

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[13] See Verwiebe for the correlation at this place, which is the same horizon as Stone Hill.

**Camarotœchia sappho** (Hall) Plate 12.

**Rhynchonella sappho** Hall, N. Y. State Cab. Nat. Hist. Rep. 13, 1860, p. 87.

**Rhynchonella (Stenocisma) orbicularis** Hall, Pal. N. Y., 1867, IV, p. 353, pl. 55, figs. 40-46.

**Rhynchonella (Stenocisma) sappho** Hall, **ibid** p. 340, pl. 54, figs. 33-34; pl. 55, figs. 47-52.

**Camarotœchia sappho** Hall and Clarke, Pal. N. Y. VIII, pt. II, 1893, p. 192, pl. 57. figs. 10-15.

**Camarotœchia orbicularis,** Hall and Clarke, **ibid**, pl. 51, figs. 46, 48, 49.

**Camarotœchia sappho** (Hall), Geol. Surv. Ohio, VII, 1895, p. 512, pl. 21, fig. 1

**Camarotœchia sappho** Grabau, N. A. Index Fossils, 1907, p. 268.

**Camarotœchia sappho** (Hall), Md. Geol. Surv. Upper Devonian, 1913, p. 174.

**Camarotœchia oribicularis** (Hall), **ibid**, p. 579, pl. 53.

The shells of this species vary in outline from broadly subtrigonal, in immature specimens, to transverse, sub-orbicular, or short-ovate, in adult specimens. The dorsal valve is usually the more gibbous.

The ventral valve is scarcely gibbous on the umbo and is usually depressed convexly. It is, however, occasionally a little transversely concave at about the middle of the shell. The posterior edges are usually slightly rounded, but in some forms they are almost straight or even slightly concave. The lateral margins meet acutely at the apex, which is usually incurved in the adult specimens. The anterior margins are slightly rounded. The center is gradually depressed in the median sinus which is ordinarily first perceptible at about the middle of the shell.

The dorsal valve is gibbous and arcuate from beak to base. The median fold is first defined at about the middle part of the shell, and is more elevated toward the anterior.

The surface is plicated by twenty to twenty-four ribs and in larger specimens there are sometimes more. There may be only fourteen or fifteen ribs on the immature shell. The ribs are strongest mesially, and become obsolete near the cardinal margin. There are usually four to seven plications in the median sinus and five to eight on the median fold. All of the central plications curve gently to the front of the shell. The lateral plications of the brachial valve are all abruptly bent toward the pedicle valve. Each rib is apically bifid for the reception of the corresponding rib of the opposite valve. The ribs on the sides are not as deeply slit as the central ones but the slit is wider. The surface of well preserved specimens is marked by fine thread-like, concentric, elevated striæ which are best defined toward the front.

The internal mold of the pedicle valve often shows a well marked muscular imprint which is delimited by a circular depression. This muscle scar extends toward the front for about half the length of the shell. At the rear it is mesially invaginated for a short distance. In the middle of this invagination there is a longiudinal sulcus which extends to the apex of the beak. The sides of the mold of the umbo are pustulose with ovarian markings. In some more perfect molds the cardinal margins of the pedicle valve show distinctly the serrate margins mentioned in the description of the genotype, *Atrypa congregata* Con. They are not as distinct in this species as in *C. allegania* (Wms.).

In his description of *C. orbicularis* (Pal. of N. Y., IV, 1867, p. 353) James Hall says, "This species presents many features in common with *Rhynchonella sappho* of the Hamilton group; and I am prepared to find in larger collections a graduation from one to the other."

In our material from the same horizon at which *C. orbicularis* was described, i.e., Upper Chemung (Conewango), no clear cut differentiation between *C. sappho* and *C. orbicularis* was possible. There was not merely a gradation such as Hall anticipated, but gradations in the same faunule.

Our upper Devonian material has been compared with many specimens in the Cornell University Museum from the Marcellus shale at Avon, LeRoy, Batavia, Stafford and Ithaca, N. Y.

We have been able to find no more pronounced gradation between these Hamiltonian and Upper Chemung specimens than almost any upper Chemung faunule shows among the specimens found therein. In other words, it seems that *C. sappho* is a persistant species which shows an almost limitless number of minor variations, one of which J. Hall referred to as *C. orbicularis.* We are referring *C. orbicularis* to synonymy under *C. sappho.*

The specimens from the Marcellus shale, which were examined, most frequently have five plications in the mesial sinus and six on the fold. There were, however, occasional specimens with a (4-5) or a (6-7) or even a (7-8) arrangement of mesial plications.

Among specimens of *C. sappho* from the Conewango in southwestern New York and northwestern Pennsylvania all of these arrangements of mesial plications are common, though in the latter faunules the (4-5) arrangement is most common.

The upper Devonian forms usually have about twenty to twenty-four plications and in rare instances a specimen has a greater number. While these super-plicated forms may represent a variety their occurrence with specimens possessing almost all the intermediate numbers of plications would seem to contradict this idea. In both Hamilton and Bradfordian strata there are occasionally found specimens which are a bit more ovate or a little more gibbous than others in the same faunule. Since these fluctuations occur in specimens from both strata one is led to suppose that he is dealing with normal and slightly over developed representatives of the same species rather than distinct species or even varieties of one species. In some of the more transverse specimens this gibbous condition is traceable in part to anterior-posterior compression during fossilization.

*Locality characteristics:*—The characters of some of the better preserved specimens from the base of the Conewango at Stone Hill, south-east of Warren, Pa., are as follows:

20 plications; 4 in the sinus and 5 on the fold; width 24 and length 19 mm.

24 plications; 4 in the sinus and 5 on the fold; width 23 and length 20 mm.

23 plications; 5 in the sinus and 6 on the fold; width 17 and length 14 mm.

22 plications; 5 in the sinus and 6 on the fold; width 20 and length 17 mm.

25 plications; 6 in the sinus and 7 on the fold; width 27 and length 23 mm.

20 plications; 4 in the sinus and 5 on the fold; width 28 and length 21 mm.

In the form with the (6-7) mesial arrangement of the ribs the dorsal fold has five plications in front and seven at its origin at about the middle of the shell. The two lateral ribs become obsolete before they reach the front margin. In one unusually gibbous brachial valve the fold is almost undifferentiated. The mold of the large ventral valve (the specimen 28 mm. wide, above) has much flattened ribs and a large muscular impression on the umbo.[14]

From Black Creek, Hudson township, Alleghany county, N. Y., in the upper Chemung (Conewango) several specimens were obtained which represent several stages in the growth of the species. One specimen has an abnormally large number of plications. The material is for the most part rather poor.

Several specimens came from the Venango First Oil Sand horizon of Verwiebe[15] about three miles south-east of Warren Pa., and one mile east of Stoneham, Pa.

From Glade, Warren county, Pa., in the Conewango at about the horizon of the 'Lamellibranch series' of G. D. Harris[16] in his section at Pope Hollow. The specimens are usually large, the width being about 26 mm. and the length about 20 mm. The plications are subangular, and five are in the sinus and six on the fold.

From a very calcareous shale two miles northwest of Warren, Pa., in strata referred to the Conewango particularly fine specimens are obtained, measuring:

| Length | Width | Length | Width |
|---|---|---|---|
| 17 mm | 27 mm | 14 mm | 17 mm |
| 18 mm | 23 mm | 17 mm | 25 mm |
| 23 mm | 25 mm | 24 mm | 26 mm |
| 20 mm | 26 mm | | |

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[14] For this locality, see U. S. G. S. Folio 172.

[15] Am. Journ. Sci. XLIII, April 1917, p. 309.

[16] Amer. Geol. VII, Mar. 1891, p. 164.

The plications vary from 20 to 28, the commoner numbers being 21, 22, or 23. There are 4 or 5 plications in the sinus and on the fold. (One specimen has a (6-7) mesial plication arrangement.)

From beds immediately underlying the Sub-Olean conglomerate at Stoneham, Pa., we have several specimens of *C. sappho.* On several specimens the plications are angular. On another with 28 visible plications they are all rounded. On this specimen the brachial fold is not elevated.

From the Bradfordian of Warren, Pa., the exact horizon undetermined, we have several young specimens of *C. sappho.* They have the usual trihedral shape and angular plications which are characteristic of the immature of this species.

We also have material from the Conewango at Kinzua, Pa. In the Oswayo at this place, a coarse quartzitic sandstone with clay inclusions, the specimens are well preserved and are normal. With them are associated *C allegania* (Wms.).

### CYRTINA Davidson

Shell small, spiriferoid, valve very unequal. The semi-pyramidal form of the pedicle valve, the high flat cardinal area, and the narrow delthyrium closed by a pseudo-deltidium, which is usually perforated by a circular foramen, separate these from the Spirifers. The shell structure is punctuate. The dental plates converge from the inner margin of the delthyrium and unite with the median septum, which reaches to the front, thus dividing the interior of the valve in two parts. Nearly the whole interior of the shell is taken up by two spiral cones, the apices of which extend into the rostral cavity of the ventral valve.[17]

**Cyrtina triplicata** Simpson Plate 14, figs. 2-10.

**Cyrtina triplicata** Simpson, Tr. Am. Phil. Soc. 16, 1888, p. 439.

**Cyrtina triplicata** Simpson, 2nd Pa. Geol. Surv., Dict. Fos. 1889, p. 181.

*Description*[18]:—Shell more or less triangular, sub-pyramidal; hinge-line equal to the greatest width of shell; proportional length and width somewhat variable; length of the dorsal valve from one-half to two-thirds the width; length of ventral valve about equal to the width; height of the area greater than the length of the dorsal valve.

[17] Original description of the genus, Pal. Soc. London, 1858, p. 66. Description in part from Grabau and Shimer **Index Fossils** and in part from James Hall, Pal. N. Y. IV.

[18] Taken in part from Simpson's original description.

Ventral valve quadrilateral, sub-pyramidal; most prominent at the beak, which is variable in elevation; straight not arching over the area, usually attenuate; lateral margins regularly rounded. Mesial sinus narrow at the beak and rapidly widening as it exends forward, and deep; where it reaches the margin of the shell it is produced forward in a sub-linguiform extension. Sides of the sinus flat, abruptly sloping, making the bottom angular. Area large, triangular, varying in height; sometimes nearly equal to the width of the shell, at other times not equal to more than half the width; slightly oblique; striated in both directions, the longitudinal striæ distinct, the vertical striæ much finer and often obsolete. Fissure moderately narrow and closed by a convex pseudo-deltidium.

There are three or four plications on each side of the sinus, the two bounding the sinus being much more prominent than the others.

Dorsal valve semi-circular or subtrigonal in outline; length from one-half to two-thirds the width. Mesial fold broad, prominent, extremely elevated in front and bounded by broader furrows than those between the plications. There are two plicaions on each side of the mesial fold, the two plications adjacent to the fold being much more prominent than the others. On some of the specimens these are nearly as prominent as the fold itself, the other two plications being obscure.

The surface of both valves is ornamented by very fine and delicate striæ which are obsolete on all but perfectly preserved specimens. There are also many conspicuous lines of growth which are more prominent on the anterior portions of the shell.

Dimensions of two specimens compared:

| | |
|---|---|
| Length | 5, 4.5 mm brachial valve |
| | 6, 5.5 mm pedicle valve |
| Width along area | 8.3, 8 mm |
| Height of area | 4.5, 4 mm |
| Width of delthyrium | 1,1 mm. at base. |

The species was originally described from the "Chemung" group three miles northwest of Warren, in Warren county, Pa. It has also been recorded by Randall from Warren, Pa.[19]

[19] 2nd Pa. Geol. Surv. Dictionary of Fossils.

Our specimens came from the Waverly at Stone Hill, Pa., not far south of Stoneham, Pa. It is the Cuyahoga formation of Verwiebe[20] or the Venango First Oil sand of geologists. The matrix is a light gray sandstone which weathers to a buff color and has an abundant fauna.

### PARAPHORHYNCHUS Weller

Shell rostrate, of rather large size, coarsely plicate with usually simple plications which extend nearly to the beak, with a deep sinus in the pedicle valve and an elevated fold in brachial valve of the mature shell. The surface of both valves is marked with very fine longitudinal striæ which increase by bifurcation and intercalation. In the interior of the pedicle valve there is a pair of vertical dental lamellæ which support the teeth and extend forward into the cavity of the valve and between which there is a narrow muscular scar. In the brachial valve a strong median septum supports posteriorly a hinge plate with a median cruralial-like cavity. Anteriorly each lateral division of the hinge plate is produced into the cavity of the shell as a crural process. The median septum also continues forward toward the front of the shell beyond the cruralium-like hinge plate. A cardinal process is wanting. The shell is fibrous in structure, not punctate.[21]

**Paraphorhynchus medialis** (Simpson) Plate 11, fig. 28.

**Rhynchonella missouriensis**, Carll, 2nd. Pa. G. S. XIV, 1883, p. 305.

**Rhynchonella medialis** Simpson Tr. Am. Phil. Soc. n. s. XVI, 1888, p. 414, fig.

**Rhynchonella medialis** Simpson, Lesley, 2nd. Pa. G. S. Dict. Fos., p. 4, 1889, p. 892.

**Rhynchonella medialis**, Randall, Pa. G. S. Final Rep., II, 1892, p. 1494.

**Rhynchonella medialis**, Schuchert, U. S. G., Bull. No. 87, 1897., p. 360.

**Paraphorhynchus medialis** (Simpson), Weller, Tr. Acad. Sci. St. Louis, XV, 1905, p. 259.

*Description*[22].—Shell broadly oval or sub-trigonal in outline; height a little less than width; greatest width about two-thirds the length of the shell from the beak. Margins from apex to widest part of the shell nearly straight, then abruptly rounding and slightly produced in front in a broad extension.

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[20] Verwiebe, Am. J. of Sc. 18, April 1917.

[21] From Weller, Tr. Acad. Sci. St. Louis, XV, 1905, p. 260.

[22] Simpson's original description, see above.

Ventral valve convex at the sides, depressed in the middle; mesial sinus commencing at the apex and growing wider at the base, where it occupies fully one-half of the width of the valve.

Dorsal valve unknown.

Surface marked by about twenty plications, of which eleven occupy the mesial sinus, and are smaller than those on the other parts of valve, there being five in the same space occupied by three of the others. The plications are rounded or subangular. There are also very fine radiating striæ covering the plications, four or five in the space of one millimeter. The striæ are crossed by lines or varices of growth. No concentric striæ have been observed, though they may occur on more perfectly preserved specimens. The specimen described measures 25 mm. in height and 30 mm. in width.

The species was described from the "Waverly" group near Warren, Pa.

*Remarks.*—The specimens pictured come from the Bradfordian beds lying between the Olean and Sub-Olean conglomerate on Stone Hill, one mile east of Stoneham, Pa., and from the same horizon on a hill just east of Cobham, Pa. The specimens are internal molds and external casts in a coarse grained, almost conglomeritic sandstone which in places is a true conglomerate. They were associated with *Spirifer disjunctus, Syringothyris angulata* and *randalli, Cyrtina triplicata, Camarotœchia sappho* and *contracta* etc.

The internal mold of the pedicle valve which was best preserved is 28 mm. in length and 30 mm. wide. The posterior lateral portions of the umbo are pustulose with ovarian markings. The cast of the diductor muscle scars extends anteriorly about 13 mm. on the umbo and is lenticular in shape. The imprint of the vascular system is very pronounced on the internal molds. One main vascular trunk extends toward the front on either side of the umbo. Each bifurcates once just posterior to the termination of the diductor muscle scar. Of the two sectors after this bifurcation the central one bifurcates once, while the lateral sector repeatedly bifurcates and sends branches toward the posterior margin. From these multiple branches of the lateral sectors the secondary vascular sinuses extend to the periphery of the shell in a pectinate manner.

**Paraphorhynchus girtyi** n. sp. Plate 9, figs. 15, 17, 18, 19, 22.

Shell large, semi-globular, sub-quadrate in general outline; external appearance very rugose with heavy radial plications and fasciculating concentric ribbing.

Ventral valve larger than the dorsal, less gibbous and with greater concentric irregularity. The surface of the internal mold has very coarse plications, four of which are in the mesial sinus and three or four on the sides. The surface is not known but undoubtedly is finely striate as it is in the other members of the genus. Large, elevated, concentric carinæ probably formed by fasciculating growth lines are a characteristic feature of the internal molds of both valves. The individual concentric striæ are best seen in the anterior part of the sinus where they are angular.

The dental lamellæ are short and strong and about six millimeters apart. Between the dental sulci of the mold there is an elevated elongate-ovate muscular platform from the margins of which extends a well developed system of vascular sinuses. On the posterior dorsal side the pedicle umbonal mold is excavated as though marking the position of a cardinal plate.

The dorsal valve is shorter and more gibbous than the ventral. It has five mesial plications on a moderately elevated fold and three well developed laterals. This valve has a very rugose appearance due to five or six very heavy concentric carinæ, in the mold form, and very strong concentric striæ. A well developed median septal imprint is shown on the mold, and dental sockets are visible cardinally.

This species differs from *P. medialis* in the fewer number of mesial ribs, the rugose appearance, the wider and less perfectly defined muscular impression. The dental lamellæ of *P. girtyi* are also larger.

*Dimensions*.—Width 29 mm.; height 26 mm.; greatest thickness about 18 mm.

*Occurrence*.— At the Venango First Oil Sand horizon, above the Sub-Olean conglomerate on the road from Scania to Smethport, Pa. The matrix is a light gray quartzitic sandstone.

**Paraphorhynchus striata,** (Simpson) Plate 9, figs. 16, 20.

Tr. Am. Phil. Soc. N. S. 16, 1889, p. 444.

Shell broadly triangular; posterior lateral margins nearly straight; greatest width of shell anterior to the middle. Species known from ventral valves only.

The mesial sinus originates early on the beak and widens greatly upon approaching the anterior margin. There are five or six plications in the sinus of a medium sized specimen and four or five on a larger one. Three very broad rounded anterior-lateral ribs are well shown on the smaller specimen and obsolete or eroded on the larger. The extreme sides are smooth.

The surface of an external cast shows indistinct radiating striæ on the bases of the sinal costæ. Concentric growth lines are present.

Internally the shell has two stout incurving dental lamellæ which extend toward the front about one-seventh the length of the shell. The diductor muscles are imbedded in the shell in an oblong depression, in the longitudinal median portion of which the adductors are attached. Just posterior to the diductor there is an elevated ridge which extends posteriorly on the beak creating an appearance, in the internal mold, very analogous to the same region in many of the *Syringothyris,* in which the posterior or middle part of the umbonal mold is notched; this may represent the attachment place of the posterior adductors. Ovarian markings are plentiful on the lateral slopes of the umbo.

*Occurrence.*— These specimens come from the Venango First Oil Sand horizon between the Olean and Sub-Olean conglomerates near Cobham, Pa. The matrix is a yellowish brown quartzitic sandstone which is very fossiliferous. It is this stratum which was formerly known among Penna. geologists as the "Berea" formation, and is quite probably the type locality for the species.

## PRODUCTELLA

**Productella hirsuta** Hall Plate 20A. figs. 11-19.

Pal. of N. Y. vol. IV, 1867, p. 166, pl. 24, figs. 17-29.

*Occurrence.*—In the green arenaceous shales of the Chemung group at Phillipsburg and Rockville, Alleghany county, N. Y., and at Covington, Pa.

**Productella hirsuta var. rectispina Hall.** Plate 19, fig. 11.

Pal. of N. Y. IV, 1867, p. 168, pl. 24, figs. 30-37.

*Occurrence.*—This variety occurs in the Chemung beds of Steuben county, N. Y., and in the beds referred to the Chemung by Hall at Meadville, Pa.

**Productella boydii Hall.** Plate 20A, figs. 1-6.

Pal. of N. Y. IV, 1867, p. 169, pl. 24, figs. 10-16.

*Occurrence.*—In the Chemung group at Phillipsburg, N. Y., and reported by Verwiebe from the Venango Oil group. (A. J. Sc. 44:92.)

**Productella lachrymosa (Conrad)** Plate 20, fig. 14.
Plate 19, figs. 8-10.

Pal. of N. Y. IV, 1867, p. 172, pl. 25, figs. 23-28.

*Occurrence.*—Common in the Chemung group. Found by Hall in western New York near Conewango, Randolph, and Ellington; reported by Lesley from the "Chemung-Catskill" beds at Warren, Pa. (Dict. of Fossils, p. 750.)

**Productella lachrymosa, var. lima (Conrad)** Plate 19, figs. 18-21.

Pal. of N. Y. IV, 1867, p. 174, pl. 25, figs. 29-32.

This variety differs from *P. lachrymosa* in having a depressed middle and shorter and more numerous tubercles.

*Occurrence.*—Found with *P. lachrymosa* in the Chemung group at Randolph, South Valley and Ellington, N. Y., and reported by Prosser from the Bedford shales at Penn Line, Pa. (Geol. Surv. of Ohio, Bul. 15, p. 391.)

**Productella lachrymosa var. stigmata Hall** Plate 19, figs. 12, 13.
Plate 20, figs. 1, 2.

Pal. of N. Y. IV, 1867, p. 174, pl. 25, figs. 33-41.

"This is one of the largest forms among Chemung species; and I am inclined to believe it may be ultimately proven specifically distinct from *P. lachrymosa.*"—J. Hall.

*Occurrence.*—In the light colored sandstone of the "Chemung group" near Olean, N. Y., and in a similar rock at Conewango and in the lower, decomposing, semi-calacareous layers at Randolph and East Randolph, N. Y.

**Productella speciosa** Hall Plate 19, figs. 4-6.

Pal. of N. Y. IV, 1867, p. 175, pl. 25, figs. 1-11.

"This species resembles some of the forms of *P. lachrymosa,* but the spiniferous tubercles are smaller and more closely arranged and more numerous, while the umbo of the ventral valve is narrower and somewhat more attenuate. The dorsal valve is studded with numerous tubercles on the internal surface, while in that species the surface is papillose with indistinct wrinkles and some distinct elevations. In *P. lachrymosa* the divisions of the cardinal process are more divergent and each division is again bilobed; while in this one the divisions appear simple."—J. Hall.

*Occurrence.*—Originally found in the Chemung group on Twenty Mile Creek in Chautauqua county, N. Y. It also occurs at New Albion and Leon, N. Y., and west of Olean.

**Productella striatula** Hall Plate 20A, figs. 7-10.

Pal. of N. Y. IV, 1867, p. 177, pl. 25, figs. 14-21.

*Occurrence.*—In some semi-calcareous bands in the Chemung group at Cherry Creek, and New Albion, Conewango, and Cold Spring, N. Y.

**Productella costatula** Hall Plate 19, figs. 1-3.
Plate 20, figs. 10-13.

Pal. of N. Y. IV, 1867, p. 180, pl. 26, figs. 9-15.

*Occurrence.*—This species occurs commonly in the Chemung group. It was originally cited from the Chemung Narrows in Chemung county; East Randolph and Randolph, Napoli, Conewango, New Albion and elsewhere in Cattaraugus county, N. Y.

**Productella acutirostrata** Hall Plate 19, fig. 7.

Pal. of N. Y. IV, 1867, p. 182, pl. 26, figs. 16-23.

*Occurrence*:—Originally described from the Chemung group at Jasper and south of Cadiz, N. Y. The illustrated specimen came from a light brown sandstone at Leon, N. Y., where it was associated with many *Ambocœlia umbonat*

**Productella bialveata** Hall
Plate 19, figs. 14, 15.
Plate 20, figs. 3, 4.

Pal. of N. Y. IV, 1867, p. 183, pl. 26, figs. 24-28.

*Occurrence.*—"In a sandstone of the Chemung at Meadville, Pa., where it is associated with *Spirifer disjunctus* and other fossils of the age of the Chemung group."—J. Hall.

**Productella onusta** Hall
Plate 19, fig. 17.
Plate 20, figs. 5-9.

Pal. of N. Y. IV, 1867, p. 184, pl. 26, figs. 29-42.

*Occurrence*:—In the arenaceous and semi-calcareous beds at Conewango, Napoli and near New Albion, N. Y.

### SPIRIFER

**Spirifer disjunctus** Sowerby
Plates 2 and 3.

**Spirifer disjuncta** Sowerby, Tr. Geol. Soc. 2nd. ser. 1840, pl. 53, fig. 8, pl. 154, figs. 12-13.

**Spirifera verneuili** Murchison, Geo. Soc. France, Bul. XI, 1840, p. 252, pl. 2.

**Delthyris chemungensis** Conrad, Journ. Acad. Sci. Phila. VIII, 1842, p. 263.

**Delthyris cuspidata** Hall (non Martin), Geol. N. Y. State, Rpt. 4th. Dist. p. 270.

**Delthyris disjuncta**, Hall **ibid.**, p. 269, fig. 3.

**Spirifer disjunctus** Davidson, Quart. Journ. of Geol. Soc. IX, 1852, p. 354, pl. 15.

**Spirifer disjunctus** Hall and Clarke, Pa. N. Y., VIII, pt. II, 1893, pp. 21, 24, 27, 37, 49, pl. 30.

In the Bradfordian and Chautauquan series of the Paleozoic there is probably no more characteristic species than *S. disjunctus.*

Although *S. disjunctus* is extremely variable in form, a general characterization might be as follows: Shells of moderately large size, the hinge line usually the greatest width of the shell. The area varies in height from moderately high to high and is usually distinct. The fold and sinus are plicate, the number of plications thereon varying. The lateral plications are simple and those in the sinus and on the fold are dichotomous, bifurcating or intercalary.

As J. Gosslet[23] has pointed out in his examinations of *S. verneuili* the European *S. disjunctus*, there are about six variations in the general shape of *disjunctus.* His groups, based on the relation of length to width, are in themselves almost selfexplanatory. They are: *Cylindrici, Attenuati, Elongati, Hemicycli, Proquadrati, Ovati.* Probably every specimen passes through several of these groups in its development, before reaching the mature stage.

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[23] For a full discussion of this article see: Wms. U. S. G. S., Prof. Paper 79, 1913.

In addition to radial plications the surface is marked by fine concentric striæ and also fine radiating striæ. These minute surface markings are usually eroded. The minute radiating striæ have a tendency to break up into pustules.

The variety *S. disjunctus sulcifer* of Hall and Clarke is rather common in a number of localities in the Bradfordian strata (see Pl. 3 fig. 8). This is characterized by having a sulcus on the middle of the median fold and often a mesial carina in the sinus.

These forms of *S. disjunctus* have slight variations or, at least, features infrequently seen on specimens from lower strata. The illustrations and the ensuing locality discussion will sufficiently depict these characters be they minor variations or apotypical features.

*Locality discussion.*—The upper beds of the Conewango at Glade, N. Y., yield some very fine internal molds and external casts of *disjunctus.* This horizon is characterized by the many fine specimens of *Ptychopteria beecheri* Hall. The matrix is a light gray quartzitic sandstone and the molds and casts are usually stained light brown. The dimensions of five average specimens from this locality are:

Ventral valves width 55 mm. and length 34 mm.
width 57 mm. and length 42 mm.
Brachial valves width 55 mm. and 30 mm.
width app. 42 mm. and length 34 mm.
width 50 mm. and length 25 mm.

The sinus is deep and broad and finely radiate, the radii increasing by bifurcation. The angles are slightly attenuate and the cardinal area of one fine specimen shows the imprint of the vertical striæ. (Plate 2, figs. 1, and 1a.). The dental lamellæ are short and strong (pl. 2, fig. 2). The dorsal valve is regular, obovate, the ribs on the fold finer than elsewhere. (Pl. 2, fig. 3.) In an older and more gibbous specimen the striæ are much coarser on the fold than in the average and the whole shell is more rugose. (Pl. 2, fig. 4.) Another specimen shows the attenuate condition of the cardinal angles very well (Pl. 3, fig. 10).

Close to the contact of the Cattaraugus and the Sub-Olean one mile east of Stoneham, Pa., and three miles south-east of Warren, Pa., there are limy layers in the sandy shale which contain many *S. disjunctus.* They are all nearly ovate and of large size. One very short and attenuate specimen comes from the same place. Near the margin of the shell on one specimen there is a remarkable constriction. The dorsal valve of another specimen shows a peculiar imprint on the cast, of a development similar to a median septum in other genera.

At the top of the Conewango three-fourths of a mile east of Glade, Pa., the Spirifers are abundant and noteworthy. Giant proportions are the rule at that place. Some are especially gibbous. Some of the pedicle molds exhibit a very large muscular impression (pl. 2, fig. 7) and the cardinal area is very concave. In another pedicle mold there is a very great extension of the posterior muscle impression along the median axis, thus creating the appearance of a misplaced syrinx. This appearance is further strengthened by an angular sulcus which lies in the bottom of the impression. The dental plates of the specimen under discussion, are abnormally long. Other specimens seem to represent gradational stages in the development of the elongate depression in the pedicle mold. This, by reversal would represent a shelf in the shell, probably the attachment-seat of the posterior adductor muscles.

*S. disjunctus,* in the Cattaraugus, at Black Creek, Alleghany county, N. Y., is very attenuate and approaches Sowerby's original figures in appearance. Several *S. disjunctus* var. *sulcifer* are also common at this locality.

At Stoneham, Pa., associated with *Spirifer alleghaniensis* and *Syringothyris angulata* were also found several specimens of *S. disjunctus* var. *sulcifer.*

Among the *S. disjunctus* from Glade, Pa., (in the equivalent of the Ptychopteria zone at Pope Hollow, N. Y.) the dental lamellæ are consistently longer and closer together than in typical specimens.

The Oswayo formation two miles west of Smethport, Pa., contains many *S. disjunctus.* The beds are well exposed along a spur railroad which goes over the mountain west of the town. The fossiliferous strata is a shell limestone and calcareous shale which weathers to a dark brown color. With *S. disjunctus* are associated many *Syringothyris angulata* and *Rhynchospirina scansa.*

Collections were also made at the following places:

The Conewango formation in Mud River, north of Warren, Pa.; Knapps formation (Oswayo) at Flat Iron Station, near Olean Rock City, N. Y.; one-half mile north of Smethport, Pa., in shales about 150 feet below the conglomerate (Sub-Olean?); lower Conewango, Stonehill, near Stoneham, Pa.; Oswayo, east of Cobhams Hill, near Stoneham, Pa.; in a light brown quartzitic sandstone, below the base of the Olean conglomerate, on the hill just south of Smethport, Pa., (The Devil's Den); Panama conglomerate (basal Bradfordian), Panama, N. Y., and at Rock Ledge near Panama, N. Y.; shales along the river at Kinzua, Pa.; Oswayo at Stickley, Pa. (This is just below the Olean conglomerate); lower Conewango at Bradford, Pa.; Robin Hill east side (middle and top), on the Chautauqua-Cattaraugus county line, N. Y., about a mile north of the Pennsylvania boundary line.

**Spirifer allegheniensis** n. sp. Plate 4, figs. 1-6; 9-11.

Shell variable in outline; usually semi-circular; hinge-line straight or only slightly angled; pedicle valve elevated; brachial valve flattened; width about 37 mm. and length about 17 mm. Surface appearance usually very rugose, especially that of the internal molds. There are from 14 to 19 coarse ribs (occasionally more) on each side of the mesial region and from 4 to 6 ribs thereon. Both lateral and mesial ribs increase by intercalation and bifurcation; the lateral bifurcation is usually restricted to the five or six ribs nearest the fold or sinus. Trifurcation is not uncommon. Deeply impressed concentric lines intersect the ribs thus causing the aforementioned rugosity.

The ventral valve is most gibbous toward the rear. The beak is slightly elevated. The sinus is shallow and begins early on the beak and extends to the margin where it ends in a very slight linguiform extension. The plications immediately bordering the sinus are usually larger than the others. Near the margin, regular concentric striæ are visible. These are continuous with the heavier varices which give the mold such a crepe-paper like appearance. The imprint of the muscular scars on the mold is much elevated. The scar is longitudinally striate, the striæ grouping themselves on either side of a slight elevation in the middle. The elevation is distinctly separated from the remainder of the shell by the abruptness with which it rises. The scar is slightly bifid behind. The cardinal slopes are pustulose with ovarian markings. The dental lamellæ are short and stout.

The boundaries of the cardinal area meet at the center at an obtuse angle.

The median fold is usually not much elevated but is very conspicuous due to deep sulci on each side of it. Two cardinal teeth are present.

This species bears some resemblance to *S. marionensis* which also has bifurcating lateral plications and undifferentiated fold and sinus. But the two species are very dissimilar in the character of the area boundaries. They are parallel in *S. marionensis* and the area of our specimens is broadly subtrigonal. In this respect they are similar to the much smaller species *S. vernonensis*. None of our specimens have the linguiform extension of the sinus of *S. vernonensis*.

This species is found in abundance in the highly fossiliferous sandstone on Cobham's Hill northeast of Warren, Pa. These are the beds called 'Corry sandstone', made a correlate of the 'Berea' by Girty[24] and later corrected to a correlate of the Venango First Oil Sand by Verwiebe[25]. On Stone hill east of Stoneham, Pa., at the same horizon it is also abundant.

### CYRTIA Dalman

The shells of this genus range in size from small to medium. They have a straight hinge-line which is the greatest width of the shell. The fold and sinus are well developed and are usually plicated. The sides are usually plicated. The cardinal area of the pedicle valve is well developed, and may be flat or arched; the delthyrium is very narrowly triangular and is covered by a pseudo-deltidium. Then dental lamellæ are well developed and often reach the middle of the shell. The brachial valve has no median septum. There is sometimes present a tube which extends into the inside of the shell. The structure of the shell is impunctate.

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[24] N. Y. Acad. Sc. Ann. 1912, p. 309.
[25] Am. J. Sc. XLIII, 1917, p. 305.

**Cyrtia alta** (Hall) Plate 3, fig. 9.

**Spirifer alta** Hall, Pr., Am. Phil. Soc. X, 1866, p. 246.
**Spirifer alta** Hall, Pal. N. Y. IV 1867, p. 248, pl. 43, figs. 1-7.
**Syringothyris alta,** Schuchert, 9th Rep. N. Y. S. Geol., 1890, p. 35.
**Cyrtia alta,** Hall and Clarke, **id.** VIII, pt. II, 1893, p. 42, pl. 26, figs. 1-5; pl. 39, figs. 37, 38.
**Cyrtia alta,** Prosser, G. S. Ohio, 4th. Ser., Bul. 15, 1912, p. 536.

The shell is semi-pyramidal with the hinge line representing the greatest width of the shell. The shell has a triangular outline when viewed cardinally and a semi-oval outline when viewed dorsally. The surface is plicate. The sinus and fold are usually plicate.

The ventral valve is much elevated. The breadth and width are about as 3 to 5. The sinus is broad and rounded at the bottom. In our specimen the pseudo-deltidium extends about two-thirds the height of the fissure. The delthyrium is 18 mm. high and 8 mm. wide at the base. The area is flat for about two-thirds the length of the shell, and then abruptly arches. A syrinx or curved septum penetrates the umbonal mold in an antero-ventral direction. There seems to be no transverse plate present from which this 'syrinx' arises. The dental lamellæ are large and converge both toward the brachial valve and toward the rear. At the cardinal area the dorsal convergence is interrupted by the diverging margins of the delthyrium. The muscular scars are represented by longitudinal striæ on the umbonal mold.

*C. alta* is associated with *Spirifer disjunctus, Syringothyris randalli* and *angulata,* and *Camarotœchia contracta* and *sappho* in the Conewango strata at Stoneham, Pa.

## SYRINGOTHYRIS

**Syringothyris angulata** Simpson Plates 6, 7, 8.

**Syringothyris angulata** Smip. Am. Phil. Soc. Tr., XVI, 1889, p. 440.
**Syringothyris randalli** Simp. **ibid.** p. 441.
**Syringothyris angulata**, Schuchert, 9th Rep. N. Y. S. Geol., 1890, p. 32.
**Syringothyris randalli,** Schuchert, **ibid.** p. 36.
**Syringothyris randalli,** Hall and Clarke, Pal. N. Y. VIII, pt. II, 1893, pl. 27.
**Syringothyris randalli,** Schuchert, Am. Jour. Sc. 1910, vol. 30, p. 223.

The shape is spiriferoid, varying from semi-elliptical or semi-ovate to narrow and attenuate. The gibbosity of the shell differs with age; old specimens are usually very gibbous and young ones regularly convex. Both valves are radially plicate on the sides. The fold and sinus are without plications. The cardinal area of the ventral valve is relatively high and may be either vertical or arcuate. The delthyrial aperture is comparatively narrow and is usually closed by a pseudo-delthryium. In some specimens this seems either partially or totally absent.

The plications of the ventral valve begin high on the beak and increase in elevation as they approach the anterior margin. They are usually sub-angular. The sinus likewise begins early on the umbo and widens toward the front where it is produced in a linguiform extension which is rather variable in the extent of its development.

The dental lamellæ are usually very elongate and bent convergently toward the front. They often nearly attain the anterior margin of the shell. In other quite normal specimens the lamellæ are little developed and straight.

In the mold of the pedicle valve the area between the lamellæ which bears the muscle scars is often elevated and posteriorly split.

The muscle scar is ordinarily very large and some instances reaches anteriorily more than two-thirds the length of the shell. This is of an ovate or sub-quadrate outline. The scar is usually made up of two bilaterally symmetrical interweaving webs of branching 'veins'. These are, on rare occasions, reduced to a series of longitudinally parallel 'veins'. The two portions of the scar are separated by an elongated platform which is laterally delimited by sulci. It is the posterior union of these sulci which forms the slit in the mold at the apex of the umbo mentioned above. In several specimens the sulci are posteriorly much widened but are separate all the way to the apex of the shell. Another common variation is that the sulci are so deep that they become part of the syrinx. The lateral slopes of the sides of the beak are usually marked by pustulose ovarian impressions.

The characters of the delthyrial parts as seen on the internal molds are as follows: The dental lamellæ converge slightly about the middle of the pedicle height. Connecting this convergence and sloping from the beak toward the brachial valve in a transverse septum which is usually dorsally angulate. This septum has never been observed extending past the front limits of the dental lamellæ. On the pedicle side the septum usually has developed mesially two parallel carinæ which converge ventrally thus forming a slit tube. This tube which is called the syrinx extends toward the brachial valve far beyond the limit of the transverse plate. The syrinx may be entirely tubular with no slit along the pedicle margin or it may be only a solid rod extending into the interior of the shell. The transverse plate is sometimes not dorsally angulate, but instead is flat, rounded, or angularly concave. In still other specimens the transverse plate is totally absent and the syrinx alone is present.

The dorsal valve is less elevated and less gibbous than the ventral and has no cardinal area. Two well defined dental sockets are present anteriorly on each side of the umbo. A strong median septum extends toward the front for two or three millimeters. Internally along the median fold a very slight carina is often present and creates the impression in the mold of a slight plication tho it does not extend far toward the front, and is totally absent externally. The fold is well elevated and reaches forward in a more or less linguiform extension.

The surface of the entire shell is uniformly marked by flattened ctenæ which gives the surface the twilled cloth appearance so characteristic of the genus. Strong concentric growth lines are usually present. They are so well developed on some specimens as to give a very rugose appearance.

This species can be immediately distinguished from any of the associated spiriferoids by the total absence of plications on the fold and sinus and the presence of the syrinx.

A comparison of the above description with that of Simpson will show many points of major difference. This description is based on characters observed on several hundred specimens of *S. angulata* from many localities in the Conewango formation in western New York and Pennsylvania and the specimens of the species *S. randalli* Simp. from the N. Y. State Museum.

Neither any of our specimens nor the types of *S. randalli* in the New York State Museum have a plicate fold or sinus as illustrated in the original description of that species. (Tr. Am. Phil. Soc. XVI, p. 441, fig. 2). This same fact has been pointed out by Girty in discussing this genus[26]. This error in the original description can only be explained by the fact that there are often associated with *Syringothyris* many *Spirifer disjunctus* which are mesially plicate. The imperfect cast or mold of one of these must have been the basis for the assumption that the species *S. randalli* was mesially plicate. Thus far no mesially plicate *Syringothyris* has been found in the Conewango.

Since the two species described by Simpson as *S. randalli* and *angulata* are identical and *S. angulata* occurs first in the original publication this species must by priority be known as *S. angulata* Simpson.

Localities at which *Syringothyris angulata* were collected are as follows: Stickley, Pa., in the conglomerate (Salamanca); Oswayo beds one-half mile east of Mt. Jewett, Pa., on the road to Smethport, Pa.; white sandstone immediately under the conglomerate (Olean) at Allegheny Springs, Warren Co., Pa.; Conewango, Portville, N. Y.; very fossiliferous strata one mile east of Stoneham, Pa. (Venango First Oil Sand); east of Cobham, Pa., between the Olean and Sub-Olean; Stone Hill near Stoneham, Pa. throughout the Conewango; Conewango, two miles northwest of Warren, Pa.; Conewango at Kinzua, Pa.; many places near Bradford, Pa., in the Conewango; top of Robin's Hill on the Onoville road, one mile east of the Cattaraugus Co. line, N. Y., about 300-500 feet above the Pope Hollow conglomerate; white sandstone at base of the Olean conglomerate on the hill south of Smethport, Pa.; Oswayo beds at a rock cut along a spur railroad track going west, about two miles from Smethport.

## ATHYRIS

**Athyris angelica** Hall Plate 9.

**Athyris angelica** Hall, 14 Rep. N. Y. S. Cab. Nat. Hist., 1861, p. 99.
**Athyris angelica** Hall. 15th Rep. **ibid.** 1862, pl. 3, figs. 10-13, 24.
**Athyris angelica** Hall, Pal. N. Y. IV, 1867, p. 292, pl. 47, figs. 9-20.
**Athyris ? polita** Hall. Pal. N. Y. IV, 1867, p. 293, pl. 47, figs. 21-23.
**Athyris angelica,** Walcott, Mon. U. S. Geol. Surv. VIII, 1884, p. 148.
**Meristella (?) incerta** Simpson. Tr. Am. Phil. Soc. 16, 1890, p. 442, fig.
**Athyris angelica,** Hall and Clarke, Pal. N. Y. VIII, pt. II, 1893, p. 90, pl. 45, figs. 26-30.

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[26] See. Schuchert, C. "On the Brachiopod Genus **Syringothyris** in the Devonian of Missouri". Am. J. Sc. 30, 1910, p. 223.
Girty, G. H., "On the Genus **Syringopleura**, Schuchert". Journ. of Geol., 1911, p. 594.

Shell usually with a sub-pentagonal outline, lateral margins the longest; usually widest below the middle; usually globular in appearance, the ventral valve being the more gibbous. Length usually greater than width.

Ventral valve largest, most gibbous posteriorly, with a well defined rounded sinus which begins early on the beak and extends forward in a linguiform extension which varies in the degree of development in individuals. Strong cardinal teeth are supported by anteriorly diverging dental lamellæ which extend anteriorly about three-fourths the length of the posterior median elevation of the mold. The beak is incurving and internally bears well defined muscular impressions. These have been well described by Hall (Pal. of N. Y., vol. IV, p. 292). Great variation in these impressions exists in the specimens examined. One common variation is a large humped anterior area of the mold of the muscular impressions. No vascular impressions were noticed. The cardinal area is short.

The dorsal valve is usually much shorter, the length and width more nearly equal. Mesial fold usually well developed, especially in the anterior half of the shell. It extends forward in proportion to the mesial sinus. The muscular impressions are usually absent. Area practically absent. Well defined dental sockets are present on either side of the low umbo. The impression of an elongate, low median septum is usually present in the internal mold.

The surface in unexfoliated specimen is well marked by concentric striæ which become lamellose at times toward the front of the shell. The entire surface bears interrupted radiating lines which are usually best developed on the sides. These give the surface of well preserved specimens a peculiarly textile-like appearance. This is particularly noticeable on specimens upon which each of the radiating striæ is slightly thickened anteriorly where it meets a varix. In some, the situation is such that each varix has the appearance of a series of small nodules. There are five striæ to a millimeter usually, with slight deviations.

In partially or entirely exfoliated specimens the short interrupted striæ are absent and in their stead there appear radiating uninterrupted striæ, usually best developed mesially[27]. These radiating striæ are normally coarser than the external ones and

[27] Walcott, Mon. U. S. Geol. Surv. VIII, 1884, p. 148.

it is only occasionally that they are fine enough to give the molds a fenestrated appearance.

Dimensions:

Length . . . . . . . . . . . . . . . . . . . . 24, 27, 23, 22, 20 mm., ventral
Width . . . . . . . . . . . . . . 23, 25, 24, 21, 23, 20 mm., both valves
Length . . . . . . . . 20, 11, 27, 18, 19, 22 mm. dorsal (not necessarily the same specimens as the above.)

All of the specimens of *Athyris* collected in the Bradfordian of western N. Y. and Pa. were referred to this species. The only character of those from the upper beds which might possibly be regarded as varietal might be their more constant transverse condition as contrasted with the more constant globular condition of those in lower beds. However, both phases occur wherever the species is found.

We are referring the species *Meristella* (?) *incerta* Simpson to *Athyris angelica* Hall largely on his description and figures. We have been unable to see the types of *M. incerta.* Among many specimens collected in the environs of Warren in the Waverly beds, which are probably the type locality for Simpson's 'species', we have many specimens which closely approach those pictured by him. We also have many almost perfect specimens, with even the delicate surface markings intact. Using the poorly preserved and crumpled material such as he pictures in his description true identification would be difficult, but average material quite certainly points to *A. angelica. A. polita* may be a good species but from all of Hall's descriptions and illustrations it seems to be based on individuals of *A. angelica* which gradate, as do many other erratic individuals, with the mass of the species. For the time being, at least, we are considering these species synonymous.

The upper Chemung *Athyris* and especially those from the Venango First Oil Sand horizon have frequently a close approximation to the Mississippian and Carboniferous *Composita.* From the decalcified specimens, the only ones obtainable, this seeming resemblance is at present based exclusively on superficial characters.

*Occurrence.*—Three miles southeast of Stoneham, Pa., in the Waverly beds, the formation referred to as Cuyahoga by Verwiebe[28]. The stratum is very fossiliferous though this species is only moderately common. It is a light gray sandstone which weathers to a buff color. It is stratigraphically just above the Sub-Olean conglomerate.

Associated with this species were *Spirifer disjunctus, Spirifer allengheniensis, Camerotœchia contracta* and *C. sppho, Syringothyris angulata, Cyrtina triplicata, Platyceras, Euomphalus,* etc.

Collections were also made in various places in the Bradfordian of Cattaraugus county, N. Y., for comparison. The specimens were also compared with material in the Geological Museum at Cornell University.

James Hall described *A. angelica* from the Chemung beds at Phillipsburg, Rockville, Great Valley, Randolph, Cadiz, N. Y., and at Meadville, Pa. His species *A. polita* came from practically the same localities in southwestern N. Y.

**Athyris lamellosa** (L'Eveillé) Plate 11, figs. 22, 23.

**Athyris lamellosa** Meek, Pal. of Ohio, II, 1875, p. 283, pl. 14, fig. 6., Hall Pal. of N. Y., VIII, II, 1893, p. 90, pl. 46, figs. 16-20.

This is a Waverlian species described from Ohio strata at Sciotoville, O. It has been reported by J. F. Carll from Titusville, Pa., in vol. 4, 2nd. Pa. Geol. Surv., p. 293.

### AMBOCŒLIA

**Ambocœlia gregaria** Hall Plate 11, figs. 24-27

**Ambocœlia umbonate** var. **gregaria** Hall, Pal. of N. Y., IV, 1867, p. 261, pl. 44, figs. 19-25.

"The ventral valve is often more elongated than *A. umbonata* and the margins of the mesial sinus are sub-angular. The dorsal valve is depressed convex with a distinct median sinus. . . The casts of the interior of the ventral valve show a longitudinal median crest in the muscular impression, which is often also limited at the sides by a linear, obtuse impressed line, as if by some callosity on the interior of the shell."—Hall.

The species is usually small and practically never reaches more than half an inch in diameter, and this size rarely.

*Occurrence*.—In western N. Y. this species is found near Randolph, New Albion and Conewango, etc. It is a characteristic upper Chemung species.

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[28] Verwiebe, Am. Journ. of Sci., 18, April 1917.

### RETICULARIA

**Reticularia præmatura** (Hall) Plate 11, figs. 4, 5.

**Spirifer Præmatura** Hall, Pal. of N. Y., 1867, p. 250, pl. 33, figs. 31-35.

Shell ovate or orbicular, hinge-line shorter than the width of the shell; the cardinal angles rounded; surface decoration consisting of sub-imbricating concentric striæ and coarser radiating striæ. The surface is not plicate, and is sometimes almost pustulose.

The ventral valve has a broad shallow sinus which is poorly defined. The beak is slightly elevated and incurved; area small, not defined.

The dorsal valve is regularly and moderately convex with only a slightly defined mesial fold.

*Occurence*.—In the 'Chemung group' at Meadville, Pa., and Oil Creek, Pa., and in the beds referable to the Venango First Oil Sand (lower Carboniferous) at Stoneham, Pa., just east of the monument and in a coarse sandstone just below the Sub-Olean conglomerate on the west side of Robin's Hill along the main highway. This is probably the same horizon as at Stoneham, Pa. It is associated with *Spirifer disjunctus, Chonetes, Productella,* etc.

### RHYNCHOSPIRINA

**Rhynchospirina scansa** (Hall) Plate 11, figs. 3, 15, 16.
Plate 13, figs. 1-7.

**Rhnychospira scansa** Hall Pal. of N. Y., VIII, II, 1895, pl. 50, fig. 45. 14th. Rept. N. Y. State Geol. 1894, p. 360; pl. 9, fig. 2.

Pedicle valve large, with prominent, somewhat arched beak; cardinal slope extending about one-half the length of the shell; outer margin semi-oval; surface with sharply defined median furrow which usually bears a single small plication; the lateral slopes have eight or ten rounded broad plications.

The pedicle valve also has a very large apical aperture. This is the most outstanding feature of all the specimens examined. The median furrow is occasionally obsolete.

The brachial valve is more gibbous and shorter than the pedicle valve. The internal mold of the brachial valve shows strong dental impressions and the imprint of an almost obsolete median septum. The median costa of the brachial valve is most frequently larger than any of the lateral costæ.

*Occurrence*.—Originally described from the 'Waverly' of Mc-

Kean county, Pa., and reported by C. Butts from the Oswayo of the Olean region. This species has been found in great abundance in the chocolate Oswayo shales two miles west of Smethport, Pa., in a rock cut on a spur railroad. It commonly occurs as internal molds of one or both valves and is usually badly crumpled.

**Rhynchospirina ? sp.** Plate 11, figs. 9-14.

In the sandstone of the Venango First Oil Sand horizon on Stone hill near Stoneham, Pa., is found a very small, multiplicate rhynchonelloid shell which might be referred to *Retzia* or *Rhynchospirina*. The specimens all consist of internal molds and external casts. The shell is posteriorly attenuate and anteriorly usually globular. The number of plications varies from about sixteen to nearly tewnty-five. The illustrations are slightly enlarged.

## PELECYPODA

### AVICULIPECTEN (*)

**Aviculipecten tenuis Hall** Plate 32, figs. 7, 8, 9.

Pal. of N. Y. Vol. V, I, 1884, p. 39, pl. 81, fig. 6; pl. 7, figs. 27-28.

*Occurrence.*—In the calcareous sandstone of the 'Upper Chemung' group at Randolph and Salamanca, N. Y.

**Avoculipecten duplicatus Hall** Plate 33, figs. 6-10.

Pal. of N. Y.., Vol. V, I, 1884, p. 17, pl. 7, figs. 1-7; pl. 81, figs. 9, 10.

*Occurrence.*—In the 'Chemung group' at Rockville, Hobbieville, Phillipsburg, East Randolph, N. Y., etc.

**Aviculipecten ellipticus Hall** Plate 32, fig. 1.

Pal. of N. Y., Vol. V, I, 1884, p. 25, pl. 7, fig. 31.

*Occurrence.*—In the sandstone of the 'Upper Chemung' at Meadville, Crawford county, Pa.

**Aviculipecten celsus Hall** Plate 32, figs. 2, 3.

Pal. of N. Y., Vol. V, I, 1884, p. 23, pl. 7, figs. 29, 30.

*Occurence.*—In the sandstone of the conglomerate associated with the 'upper Chemung' at Salamanca, N. Y.

**Aviculipecten striatus Hall** Plate 32, figs. 4,6.
Plate 31, figs. 2-5.

Pal. of N. Y., Vol. V, I, 1884, p. 22, pl. 10, figs. 3, 4.

*Occurrence.*—In the middle Chemung at Painted Post and Chemung Narrows and in the Chemung at Warren, Pa. Common in the sandstones immediately below the outcropping conglomerate at Stickley, Pa. (See Plate 31.)

*Note: Orthography **fide** Girty.

**Aviculipecten æquilateralis** Hall Plate 32, fig. 10
Plate 31, fig. 1.

Pal. of N. Y., Vo. V. I, 1884, p. 19, pl. 82, fig. 1.

*Occurrence.*—In the upper beds of the 'Chemung group' at Allegany Sulphur springs, Warren county, Pa. Specimens very close to this species have been taken in the Conewango formation two miles northwest of Warren, Pa.

**Aviculipecten patulus** Hall Plate 33, figs. 1, 2.

Pal. of N. Y., Vol. V, I, 1884, p. 24, pl. 7, figs. 32, 33.

*Occurrence.*—In conglomerate and sandstone associated with the upper 'Chemung group' at Rock City near Salamanca, N. Y. Reported by C. Butts from the Wolf Creek and Salamanca conglomerates[29].

**Aviculipecten cancellatus** Hall Plate 33, figs. 3, 4, 5.

Pal. of N. Y., Vol. V, I, 1884, p. 18, pl. 7, figs. 12, 14-19.

*Occurrence.*—In the middle members of the Chemung group as exposed at Phillipsburg and Rockville, Allegany county, N. Y., and at Conewango and near Westfield, N. Y.

**Aviculipecten æquilata** Simpson Plate 32, fig. 5.

Tr. Am. Phil., Soc. n. s. 16, 1890, p. 445. il.

*Occurrence.*—In the 'Chemung group' north of Warren, Pa.

### LYRIOPECTN

**Lyriopecten solox** Hall Plate 33, fig. 11.

Pal. of N. Y., Vol. V, I, 1884, p. 56, pl. 25, fig. 5.

*Occurrence.*—In a fine grained calcareous argillaceous sandstone (lying above the Panama conglomerate) of the upper 'Chemung group' near Panama, N. Y.

**Lyriopecten fasciatus** Hall Plate 35, figs. 1, 3.

Pal. of N. Y., Vol. V, I, 1884, p. 55, pl. 9, figs. 10, 11.

*Occurrence.*—In the Chemung group at Leon, Cattaraugus county, N. Y.

**Lyriopecten alternatus** Hall Plate 32, fig. 6.

Tr. Am. Phil, Soc, ns. 16, 1890, p. 446. il.

*Occurrence.*—In the 'Chemung group' at Warren, Pa.

### PTERINOPECTEN

**Pterinopecten suborbicularis** Hall Plate 34, figs. 1, 2, 4, 9.

Pal. of N. Y., Vol. V, I, 1884, p. 80, pl. 8, figs. 1, 2; pl. 24, fig. 10; pl. 82, fig. 6.

*Occurrence.*—In the 'Chemung group' at Hobbieville and Little Valley, and New Albion, N. Y. It is also found at Mansfield, Pa. Butts found this species above the Salamanca conglomerate[30].

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[29] Bul. N. Y. State Mus. no. 69, p. 994.

### CRENIPECTEN

**Crenipecten amplus Hall** Plate 34, fig. 3.

Pal. of N. Y., Vol. V, I, 1884, p. 81, pl. 9, figs. 9, 13, 18.

*Occurrence.*—In the shales of the Chemung group at Rockville, Allegany county, N. Y.

**Crenipecten crenulatus Hall** Plate 34, figs. 3, 8.

Pal. of N. Y., Vol. V, I, 1884, p. 82, pl. 9, figs. 6-8, 15-17.

*Occurrence.*—In the shales of the 'Chemung group' at Rockville, Allegany county, N. Y.

**Crenipecten impolitus Hall** Plate 34, fig. 5.

Pal. of N. Y., Vol. V, I, 1884, p. 83, pl. 9, fig. 14; pl. 83, fig. 10.

*Occurrence.*—In a coarse sandstone of the 'Chemung group' near Olean, Alleghany county, N. Y.

**Crenipecten micropterus Hall** Plate 34, fig. 6.

Pal. of N. Y., Vol. V, I, 1884, p. 86, pl. 9, fig. 23.

*Occurrence.*—In the shales of the 'Chemung group' at Phillipsburg, Alleghany county, N. Y.

**Crenipecten liratus Hall** Plate 35, figs. 7, 8.

Pal. of N. Y., Vol. V, I, 1884, p. 87, pl. 19, fig. 24; pl. 83, fig. 9.

*Occurrence.*—In the 'Chemung group' at East Randolph, N. Y.

**Crenipecten winchelli Hall** Plate 36, figs. 1-3.

Pal. of N. Y., Vol. V, I, 1884, p. 89, pl. 9, figs. 1-2, 4, 25-30.

*Occurrence.*—In the Waverly sandstone of Newark, Ohio. In the Bedford shales of Ohio according to G. Girty[31] and in the Salamanca conglomerate according to C. Butts[32].

**Crenipecten leon Hall** Plate 35, figs. 4, 5.

Pal. of N. Y., Vol. V, I, 1884, p. 88, pl. 9, fig. 12; pl. 83, fig. 8.

*Occurrence.*—In the sandstone of the 'Chemung group' at Leon, Cattaraugus county, N. Y.

### LEPTODESMA

Genotype: **Leptodesma rogersi Hall**[33]

The genus Leptodesma differs essentially from *Leiopteria* in the acuteness of its anterior cardinal angle and the absence of a lobate ear. The hinge is narrow and bears a small lateral tooth just behind the beak and nearly parallel to the hinge line. The ligament is external and the area extends the entire length of the hinge line and is longitudinally striate. The surface bears concentric growth lines.

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[30] Bull. N. Y. State Mus. No. 69 p. 994.

[31] N. Y. Acad. of Sc. 22, p. 307.

[32] Bul. N. Y. State Mus. No. 69, p. 994.

[33] See Clarke, J. M. "Composite Generic Fundamenta" Am. Geol., Vol. 13, 1894, p. 286.

The genus *Leptodesma* is probably one of the best known of all the Pelecypod genera occurring in the upper Chemung and Waverly groups of western New York and northwestern Pennslyvania.

The variations of this genus might be termed the Paleozoic counterpart of our recent *Unionidæ*. It is now very difficult to make any specific determinations in this genus and the problem will grow in complexity so long as individual specimens constitute a species and intermediate forms are unknown. The problem at hand is not to attempt to point out other than obvious relationships, but is rather to bring together most of the forms described from this particular region and show what few new forms have been discovered. The true value of the many species and varieties must await someone with much larger collections and a 'monographic complex.'

Of the more than fifty species of *Leptodesma* described by James Hall about seventeen are discussed herein. All of these have been described from the upper Chemung (including Conewango) and Waverly groups of northwestern Pa. and N. Y., or else they have been reported from these horizons.

Where possible the type specimens have been studied and in many of the specific discussions the original descriptions have been largely incorporated.

**Leptodesma myiliforme** Hall Plate 24, fig. 2
Plate 40, fig. 9.

**Leptodesma mytiliforme** Hall, Pal. N. Y., Vol. V, pt. II, 1883, p. 235, pl. 25, figs. 7, 11.

Description from Hall:

> Shell of medium size elongate-ovate; body narrowly elliptical, becoming attenuate in front, oblique, making an angle of nearly 45 degrees with the hinge-line; length more than one-third greater than height; ante-byssal margin oblique, gently curving into a scarcely perceptible sinus. This gives a slightly concave or straight margin which extends for two-thirds the length of the valve; posterior margin rounded.
>
> Left valve regularly convex in the lower half, becoming contracted gibbous and subangular above the middle. The right valve is smaller, the hinge-line proportionately longer, the base of the valve and the wing much more depressed, and the umbonal region narrow and more angular.

> Hinge-line straight and about equal to the height of the valve.
>
> Beaks sub-anterior, directed forward, acute, scarcely rising above the hinge-line. Umbonal region narrow and gibbous, subtending a very acute angle.
>
> Anterior end short, abruptly attenuate, acute, limited by a shallow byssal depression which extends for half the length of the valve. Wing large, not strongly limited, extending nearly to the posterior extremity of the body; margin very oblique, not concave, nor recurved below the cardinal line.
>
> The surface marked by concentric striæ which are crowded into fasicles on the anterior side.

The illustration of the type specimen of this species is natural size.

*Occurrence.*—The specimens came from what was Hall's type locality in a coarse-grained sandstone, which in places approaches a conglomerate, along the road from Smethport to Olean. The outcrop is about one-eighth of a mile out of Smethport. The sandy layers are stained a rusty brown and all the fossil molds or casts are covered with a coat of rust. Associated with L. *mytiliforme* were many *Orbiculoidea* and Spirifers.

**Leptodesma disparile Hall** Plate 22, figs. 7, 8, 9, 10, 11.
Pal. of N. Y., Vol. V, I, 1884, p. 186.

Shell small to medium in size; body ovate, oblique to hinge at about 45 degrees. Ante-byssal margin oblique; basal and posterior margins regularly rounded.

Left valve convex below, gibbous above; right valve flat or concave below, slightly convex in the middle and gibbous on the beak.

Hinge-line straight and greater than the length of the shell.

The beak is elevated a little above the hinge-line and extends slightly forward.

The wing bears an elongate spine. The hight valve is smaller than the left and the wing is more extended and less defined, while the large anterior end is well defined by a byssal sinus.

The surface bears concentric lamellose ridges with finer lines of growth between them.

The large anterior end, narrow umbo, large and extended wing, and only slightly sinuate anterior margin characterize the species.

*Occurrence.*—The type specimens of this species come from a coarse sandstone of the 'Chemung group' in McKean county, Pa., and Cattaraugus county, N. Y. The matrix in which they are embedded is identical with the Sub-Olean conglomerate, blocks of which are common at Smethport, Pa., just under the Olean conglomerate on the hill south of the town at what is locally known as 'The Devil's Den'.

**Leptedesma potens Hall** Plate 21, figs. 1, 4, 5, 6, 7, 9.

Pal. of N. Y., Vol. V, I, 1884, p. 188 Plate 41, fig. 3.

The members of this species are among the largest Leptodesmas found commonly in the upper Chemung.

The shell is sub-rhomboidal; body ovate, oblique, broad below; length more than one-third greater than the height. Anterior margin is sub-truncate; basal margin curving.

Valves about equally convex; right valve shorter and wider than the left and slightly more gibbous on the umbo.

The straight hinge is the greatest length of the shell.

Beak sub-anterior, elevated, curving over the hinge-line. Wing large and triangular bears a spine terminally; separated from the umbo by an abrupt, even, subangular slope. Anterior byssal portion of the shell rather small, angular in front and separated from the umbo by a poorly defined depression.

Surface with concentric growth lines which become fasciculous at intervals and are lamellose in front.

The illustrations of the type specimens are natural size.

This species is closely related to *L. mortoni* Hall.

*Occurrence.*—Upper Chemung at Olean, Portville, and East Randolph, N. Y.

**Leptodesma potens, var. juvens Hall** Plate 21, fig. 5.

Pal. of N. Y., Vol. V, I, 1884, p. 189.

While this variety is more extended and more acute in front than the typical *L. potens* it is quite possible that it is only an immature form of that species as Hall intimated when he described the variety.

The illustration of the type specimen is natural size.

*Occurrence.*—The same as for *L. potens* Hall.

**Leptodesma becki Hall** Plate 22, fig. 17

Pal. of N. Y., Vol. V, I, 1884, p. 185.

This species was originally described by Hall from the Middle Chemung beds at Corning, N. Y., with a possible specimen of this species from the Chemung in Cattaraugus county, N. Y. It is this latter specimen in which we are interested. This specimen probably does not belong to the species *L. becki* Hall. There is no good evidence for a spinous extremity to the wing as is characteristic *L. becki.* The posterior margin is nearly straight instead of slightly concave. In addition to these characters this specimen has an alar furrow and fold as well developed as in *Ptychopteria.* In fact the whole appearance of the specimen is that of a smooth Ptychopteroid form. It probably occurs below the Conewango formation which is characterized by true Ptychopteria.

The species *L. becki* probably is limited to the middle Chemung and except for this one specimen seems to have never been recorded from the upper Chemung.

**Leptodesma umbonatum**, var. **depressum** Hall Plate 22, figs. 4, 5.

Pal. of N. Y., Vol. V, I, 1884, p. 199.

Shell of medium size, rhomboidal; body very oblique. ovate; length once and a half greater than the height; ante-byssal margin regularly curving into the ventral margin which is broadly rounded and posteriorly recurved.

Left valve convex below, gibbous above. Right valve smaller, a little less convex, abruptly gibbous on the umbo.

Hinge-line straight, somewhat less than the greatest length of the shell. Beaks sub-anterior, obtuse, directed forward slightly, very prominent, and arched over the hinge-line.

Anterior end short, large, limited by a broad, poorly defined depression; acute in front. Wing large and triangular not clearly separated from the umbo; termination acute but not attenuate.

Surface marked with concentric striæ which regularly fasciculate on the body and become lamellose anteriorly.

The illustrations of the type specimen are natural size.

The species *L. umbonatum* of which we have no specimens at hand, is more convex, and narrower in the lower part of the body and has a pronounced anterior sulcus. The posterior slope is less elevated and the ante-byssal portion of the shell is larger.

*Occurrence.*—Upper Chemung at Napoli Center, Cattaraugus county, N. Y. This is quite probably a Conewango species.

**Leptodesma stephani** Hall Plate 22, figs. 12, 14, 15.

Pal. of N. Y., Vol. V, I, 1884, p. 194. Plate 41, fig. 2.

Shell larger than medium forms of the genus. Post umbonal slope nearly straight, obliquity with the hinge-line about 30 to 40 degrees. Ante-byssal margin truncate above, curving below into a sinus.

Left valve slightly larger and more gibbous in the umbonal portion than the right valve.

Hinge-line straight and equals nearly the length of the valve.

Beaks sub-anterior and directed forward, obtuse, prominent, elevated slightly above the hinge-line.

Anterior end large, short and defined by a nearly vertical byssal depression. Wings large and ending in a spine. Rear margin concave above and convex below.

Shell of average thickness, externally marked by lamellose concentric varices which differ in size and are best devleped toward the front of the shell.

To this species probably belong *L. billingsi* Hall and *L. curvatum* Hall.

The illustrations of the type specimens are natural size.

*Occurrence.*—Upper Chemung at Bradford, Pa.

**Leptodesma mortoni** Hall Plate 22, figs. 1, 2, 3.

Pal. of N. Y., Vol. V, I, 1884, p. 190.

Shell larger than medium, body elongate, ovate, oblique; posterior margin extended and abruptly recurved.

**NOTE:—**

Among the type specimens of **L. curvatum**, **billingsi** and an incomplete specimen of **L. stephani** great similarity exists The only differentiating character is the slight difference in the size of the ante-byssal portions of the shells. **L. stephani** has the larger anterior; this portion is smaller in **L. billingsi** and smallest in **L. curvatum.**

The species **L. curvatum** is based on a badly eroded specimen from which the surface markings are almost absent and the extremity of the wing is absent. The type also appears to have undergone crushing in the process of presevation. While **L. Curvatum** and **L. billingsi** may be specifically different their characteristics seem to depend on mechanical rather than biological forces.

The resemblance of **L. billingsi** to **L. stephani** is very great as the illustrations (Pl. 14, figs. 6, 12, 15,) show.

It seems almost futile to try to establish a species of such fragile things as these Paleozoic aviculoids on one or two specimens and these very imperfect. The characterization of such a species must at best depend in some degree upon a hypothetical form constructed from the fragments which all too often fail to substantiate the hypothesis.

**L. billingsi** was found by Hall in the Chemung beds at Panama, N. Y., and L. curvatum in the "Sub-Olean" sandstone near Smethport, Pa.

Left valve larger than right; convex below and more gibbous above. Right valve slightly convex below and abruptly gibbous on the umbo.

Hinge-line straight and less than the height of the shell.

Beaks nearly anterior, erect, prominent, arching over the hinge-line.

Anterior end acute and nasute; wing large and triangular; margin slightly convex. Posterior margin concave, extremely produced and very acute.

Right valve slightly smaller than left but otherwise very similar.

The surface is concentrically striate, the striæ becoming fasciculate in places and giving the surface a somewhat undulating appearance.

Illustrations of type specimens natural size.

The pictures shown are from a very poor type specimen and this particular one more closely resembles *L. potens* than other specimens of the species *L. mortoni* described and pictured by Hall. In fact the similarity between all of the type specimens of *L. potens* and *L. mortoni* is rather close.

*Occurrence.*—The Chemung group at Portville, and Little Genesee, Alleghany county, N. Y. This is probably found only below the Conewango in the true Chemung.

**Leptodesma matheri Hall** Plate 21, figs. 11, 12.
Pal. of N. Y., Vol. V, I, 1884, p. 190.

Shell of medium size, approximately rhomboidal; body oblique, meeting the hinge-line at about 45 degrees. Ante-byssal margin vertical; length about one-half greater than the height.

Left valve moderately convex below and scarcely gibbous above; right valve shorter and less convex.

Hinge-line straight; its entire length about equaling the height of the shell.

Beaks at about anterior third of the shell; obtuse, directed forward, not prominent.

Anterior end of moderate size, produced and apically acute. Wing not large with the extremity nearly right-angled. The posterior margin is slightly concave; the wing is separated from the body by a very abrupt post-umbonal slope.

Shell thin, marked by fine concentric striæ which are spaced about equidistant on the body but are fasciculate on the anterior.

The illustrations of the type specimens are natural size.

*Occurrence.*—Upper Chemung beds at Bradford, Pa.

**Leptodesma mentor Hall** Plate 21, figs. 10, 14.

Pal. of N. Y., Vol. V, I, 1884, p. 205. Plate 24, fig. 5.

Medium sized shell, sub-rhomboidal; body elongate, ovate, narrow at anterior end, oblique, meeting the hinge-line at about 40 degrees. Length one-third greater than height. Ante-byssal margin subtruncate, curving gradually into a sinus which separates the anterior portion of the shell from the umbo.

Left valve moderately convex in the lower part, becoming more convex in the middle and gibbous above.

Hinge-line straight and equal to the height of the valve.

Peak sub-anterior, forward pointing, acute, elevated only slightly above the hinge-line. Umbonal region very narrow, well elevated and with precipitous sides. Ante-byssal portion of the shell of average size and with an acute anterior.

Wing well defined by a shallow groove, though this is occasionally absent. Rear margin oblique, and slightly concave just below the cardinal line.

Shell thin and marked by undulating concentric growth lines which are regularly fasciculous.

Illustrations of the type specimens are natural size.

The species *L. mentor* or some closely allied form of its general appearances seems to have been the mean of great variation in the time represented by the Sub-Olean sandstone of this region in western N. Y. and Pa. It seems that an almost infinite number of variations of this one type are present in these sandstones. While they probably developed along regular lines the few widely separated forms that have been found seem almost specifically different from their associates, and as distinct species many of these have been differentiated in the past. While the precise determination of the standing of the species, if it is ever made, must await the coming of someone with an exhaustive curiosity and a monographic *penchant*, we are referring the most obviously variational forms to the species *L. mentor* giving some specimens, where it seems advisable, variety ranking.

*Occurrence.*—South of Smethport, Pa., in McKean county, Pa. The horizon is probably Sub-Olean, for this is probably the coarse sandstone Hall referred to in his original description. All of our specimens come from that horizon.

**Leptodesma mentor, var. orodes Hall** Plate 21, figs. 8, 13, 15.

**Leptodesma orodes** Hall, Pal. of N. Y., Vol. V, I, 1884, p 206.

This variety differs from *L. mentor* by being less oblique, with a slightly less attenuate body, and a wing which is indistinctly delimited by an alar furrow. The furrow when present in *L. mentor* is usually very well developed but is frequently absent. The sides of the shell are more nearly parallel in *L. mentor orodes* than in *L. mentor.*

The type specimens of Hall's species *L. mentor, orodes and beckii* all show evidences of an alar fold and furrow; on some of the specimens these are very similarly located to the same in *Ptychopteria.*

Illustrations of the type specimens natural size.

*Occurrence.*—Associated with *L. mentor* in the Sub-Olean sandstone between Olean, N. Y., and Smethport, Pa.

**Leptodesma mentor, var. biton Hall** Plate 22, fig. 18.

**Leptodesma biton** Hall, Pal. of N. Y., Vol. V, I, 1884, p. 222.

This variety differs from *L. mentor orodes* by having a more acute anterior extremity and by having a larger wing which is distinctly concave on the margin. *L. mentor biton* is also larger than the true types of *L. mentor orodes.* (The one exception being a badly crumpled specimen of *L. mentor orodes,* Pl. 50, fig. 15).

The concavity of the wing of *L. mentor biton* is probably only the slight concavity seen on the wings of *L. mentor orodes* magnified by growth. The one real difference between *L. mentor orodes* and *L. mentor biton* is the slightly greater extent of the forward part of the shell in *biton.*

*Occurrence.*—The Sub-Olean conglomerate or sandstone near Smethport, McKean county, Pa.; associated with the other forms of *L. mentor.*

**Leptodesma mentor var. maclurii Hall** Plate 22, fig. 13.

**Leptodesma maclurii** Hall, Pal. of N. Y., Vol. V, I, 1884, p. 228.

This variety is of the general *L. mentor biton* shape with the *L. menton* alar furrow and well defined byssal sinus developed still further, especially in the right valve. While this is probably not a good variety, evidence is insufficient at present to refer it to synonymy under any of the other varieties or species.

*Occurrence.*—Associated with *L. mentor* var. *biton* in the sandstones at Smethport, Pa.

**Leptodesma mentor, var. rude Hall** Plate 21, fig. 3.

**Leptodesma rude Hall,** Pal. of N. Y., Vol. V, I, 1884, p. 221.

Shell large, subrhomboidal, body ovate below and rapidly attenuating above. Umbo and hinge-line meet at about 50 degrees. Ante-byssal margin sub-truncate, curving into a broad sinus; ventral and posterior margins broadly rounded.

Left valve convex below, narrower and gibbous above. Right valve less convex. Hinge-line straight.

Beak in anterior third of the shell, slightly elevated.

Anterior portion large, limited by a nearly vertical byssal depression; wing rather small, demarked by an indistinct sulcus; termination acute as indicated by the outward swing of the growth lines.

Shell evidently thick, marked by concentric varices which become decidedly lamellate and leave strong impressions on the internal molds. "These surface markings are subdued in the right valve".

The illustration of the type specimen is natural size.

The coarse irregular appearance of this shell seems to be the characterizing features. It is probably not a good variety but until a good intermediate series can be formed it must stand. It probably is only another individual variation of the *L. mentor* gens.

*Occurrence.*—The Sub-Olean sandstone at Smethport, Pa., which is characterized by the *L. mentor* gens.

**Leptodesma mentor, var. sulcata** n. var. Plate 23, fig 2
Plate 24, fig. 7.

Shell large; hinge-line straight. Anterior byssal margin nearly truncate, broadly rounding below into the byssal sinus; basal margin broadly rounded. Rear margin convexo-concave, sigmoidal. Posterior alar extremity unknown, though evidently not attenuate.

Wing elongate triagonal, of medium size, demarked from the gentle post-umbonal slope by a usually well defined sulcus. Ante-byssal portion of average size, separated from the steep anterior umbonal slope by a definite byssal sinus.

Right valve slightly smaller than the left with the byssal sulcus usually better developed and alar sulcus less evident.

Body elongate; basally ovate; apically nearly acute. Body regularly convex basally, gibbous anteriorly. Beak slightly elevated, forward pointing and not extending over the hinge-line.

Surface concentrically lamellate. The ante-byssal portion of the shell usually with well-developed concentric striæ which are fasciculous or imbricating.

This variety most closely resembles *L. mentor biton* in shape and general character of the left valve though *L. mentor sulcata* is larger and with a well-developed alar furrow. The right valve is quite similar to the same valve of Hall's *L. machuri,* both having the byssal sinus very well developed. *L. sulcata* is much larger and has a greater posterior length. It differs from the species described by Simpson[34] as *L. leiopteroides* in that the sulcus is more pronounced and the ante-byssal portion of the shell in *L. m. sulcata* is much larger.

*Dimensions.*—Hinge-line app. 47 mm.; 38 mm.; anterior length about 55 mm.; 50 mm.; posterior length about 37 mm.; 32 mm. These are for left valves. The right valve is slightly smaller but the one attached specimen is too imperfect to permit measurements.

The specimen illustrated on Plate 24, fig. 7, may prove to be a separate variety; the body is considerably narrower and the beak less elevated above the hinge-line, and the hinge-margin more sinuate.

*Occurrence.*—The Sub-Olean sandstone at Smethport, Pa., at what is locally known as the 'Devil's Den', and in the Oswayo formation one mile east of Mt. Jewett, Pa., on the road to Smethport, Pa.

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[34] Simpson, G. B. Tr. Am. Phil. Soc. N. s. Vol. 16, 1888, p. 447, il.

**Leptodesma mentor, var. maxima** n. var. Plate 24, fig. 1, 4, 6.
Plate 23, fig. 4.

Shell large, moderately oblique; hinge-line straight and nearly equal to the posterior length. Ante-byssal margin truncate, rounding into a broad sinus. Anterior margin continues almost straight to the base which is narrowly rounded. Posterior margin slightly undulating, little convex immediately below the cardinal line. Posterior extremity, unknown but the growth lines suggest a slight acuteness.

Regularly convex basally, arched mesially and gibbous anteriorily. The umbo is prominent and slightly elevated above the cardinal line.

Wing and ante-byssal portions large, the former undefined and the latter well defined.

The surface is marked by concentric varices of growth which are best developed marginally and anteriorly.

The right valve is considerably smaller and has a larger ante-byssal portion than the left valve.

Hinge-line 46, 37 mm.; front margin 55, 42 mm.; rear margin 35, 33 mm.; no perfect right valve is known.

This is probably closely related to the new variety *L. mentor sulcata* though the differences are sufficient on the present criteria to separate them.

*Occurrence.*—Sub-Olean sandstone on the hill southeast of Smethport, Pa. Associated with the other forms of *L. mentor*.

**Leptodesma mentor**, var. **alpha** n. var. Plate 24, fig. 2.

Shell large, oberect. Lateral margins nearly parallel; base well rounded; hinge-line straight; front angle acute but not attenuate; posterior angle slightly attenuate. Anterior margin almost straight or only slightly convex with a slight concavity at the base of a small ante-byssal portion. Posterior margin convex basally and slightly concave as it nears the hinge-line. Concentric striæ well developed anteriorly and near the periphery of the shell at the basal and posterior-basal portions.

The front umbonal slope is very short and sharply declining, posterior slope more gradual and undifferentiated from the rather large wing.

The dimensions of the shell are: Hinge-line app. 31 mm.; rear margin 35 mm.; front margin about 45 mm.; distance from beak to base along the umbonal ridge about 52 mm.

This shell has much in common with *L. mentor,* var. *orodes* Hall, especially in the nearly parallel condition of the sides of the shell. The variety *alpha* is much larger than any described forms of the variety *orodes.* While this form is sufficiently different to have variety rank according to the established criteria for this genus, it may later be shown to be an adult or over-developed form of *orodes* or some closely allied form.

*Occurrence.*—Oswayo formation one mile east of Mt. Jewett, Pa., on the road to Smethport, Pa. This was associated with *L. carinifera.*

**Leptodesma ruedemanni** n. sp. Plate 23, fig. 4.

Shell triangular in outline, large. Hinge-line straight; posterior margin nearly straight, with a very slight concavity near the middle of the wing. Posterior margin meets the hinge-line at about 85 degrees. The posterior basal angle is sharply rounded. The basal anterior margin is sharply recurved into the anterior margin which is nearly straight to the byssal sinus. Little of the margin is known beyond this point, though the evidences point to a well-defined and relatively large ante-byssal portion of the shell.

Shell regularly convex below and arcuate above. The umbo is probably the most gibbous portion of the shell. The anterior umbonal slope is abrupt and narrow; the posterior slope wide and gentle; continues with almost a constant gradient on to the wing which is large and triangular and undefined.

Species known only from a single right valve.

The surface of the internal mold is nearly smooth with weak concentric growth lines showing on the anterior umbonal slope.

*Occurrence.*—On the hill south of Smethport, Pa. The matrix is a fine grained quartzitic sandstone which weathers to a light buff color. This locality, locally known as the 'Devil's Den', is a rock city made by huge blocks of Olean conglomerate. Underneath this is the fine-grained sandstone with an abundant aviculoid fauna. This latter horizon is probably Sub-Olean.

**Leptodesma carinifera,** n. sp. Plate 24, fig. 3.

Shell very large, elongate, very oblique. Cardinal line straight. Anterior end not produced forward; posterior extremity unknown, but growth lines suggest an obtuse condition. Ante-byssal margin sub-truncate; anterior margin almost straight or slightly undulating (lower basal portion of anterior partially covered by matrix). Base well rounded and short.

Umbo terminating in anterior third of shell; well elevated, prominent, curving over cardinal line. The umbonal fold is much elevated in the form of a sub-angular carina which extends from the umbonal apex to near the base of the shell. Greatest elevation of the umbonal fold is before the hinge-line. Anterior umbonal slope regularly inclined, broad. Ante-byssal portion comparatively small and indistinctly defined. Post umbonal slope very abrupt anteriorly but becoming more gradual basally.

Surface marked by concentric growth lines which are impressed on the cast of the interior. They become slightly fasciculate anteriorly.

Hinge-line measures about 50 mm.; anterior length about 83 mm.; posterior length at least 42 mm.; distance along umbonal carina from apex to base 87 mm. Height about 22 mm. Width of anterior umbonal slope from crest to anterior margin 22 mm.

Associated with this large *Leptodesma* were many fragments of aviculoid shells, *Syringothyris angulata, Spirifer disjunctus, Camarotœchia allegania,* and *Ctenacanthus* spines, as well as an abundant poorly preserved flora.

*Occurrence.*—One mile southeast of Mt. Jewett on the road to Smethport, Pa. The horizon is characterized at this place by an abundance of flattened clay pellets and rounded quartz pebbles which are scattered throughout the greenish-brown sandstone. The faunule is probable of Oswayo age.

**Leptodesma parallelum** Simpson Plate 37, fig. 9.

**Leptodesma parallelum** Simp. Tr. Am. Phil. Soc. n. s. 16, 1888, p. 448.

Shell small, slightly oblique; body ovate; byssal margin often nearly parallel with the hinge-line; length usually a little more than twice the height; anterior margin rounded; basal margin nearly straight, a little constricted anterior to the middle; abruptly recurving to the posterior basal extremity; the posterior margin obliquely truncate.

Left valve convex on the umbo and flattened basally. Right valve slightly more convex than the left.

Hinge-line straight and equal to about three-fourths of that of the shell. Beak about one-fourth the length of the shell from the anterior end, prominent, directed forward; umbonal region convex; posterior slope steeper than anterior.

Anterior end short, angular at the extremity and rounded below. A depression extends from the beak to the basal margin a little anterior to the middle. Wing very narrow, joining the body near the posterior extremity; margin of wing straight, oblique; extremity obtusely angular. The wing is distinctly separated from the body.

The surface is marked with concentric striæ which frequently fasciculate on the front portion of the shell.

This species, if valid, is one of the most interesting of the many aviculoids occurring in the Devono-Carboniferous transition ground, for it has, according to the description, characters of *Leptodesma, Prorhynchus* and *Ptychopteria.* The exact stratigraphic position is unknown, but from its shape and affinities it seems to belong to the basal Conewango or upper Chemung.

*Occurrence.*—In the 'Chemung group' on a hill north of Warren, Pa.

**Leiopteria cornelli**, n. sp. Plate 25, figs. 1, 3, 10.

This species has the sub-rhomboidal, moderately oblique aviculoid shell which is characteristic of the genus. The hinge-line represents the greatest width of the shell. The length and width are to each other about as two is to three. Basally the shell is broadly rounded. The anterior margin arises from the base by a broad curve and continues almost straight to a little beyond the middle where it is slightly concave. It then becomes moderately convex as it extends around the ear. The front angle is oblique. The posterior margin is sigmoidal and cardinally attenuate. The gibbosity of the two shells is about equal. The umbo is decidedly anterior and is slightly elevated above the hinge-line. Its frontal margin curves abruptly to the small ear and the posterior margin more gradually curves to the large wing.

Concentric striæ are present on both valves; those on the right valve being unusually strong. They are best developed on the hinder part of the umbo just before it slopes to the wing. The varices follow the outline of the shell and in so doing are sigmoidal on the wing and convex on the ear. They become obsolete before they reach the cardinal line and also on the anterior part of the umbo. Indistinct radiating lines also present.

The concentric striæ of the left valve are weaker and have none of the regualrity of those on the right. They are more nearly like those of both valves of the majority of the species of this genus. The ear of the left valve is separated from the umbo by an abrupt declension, which may be accentuated by crumping.

Evidences of dentition and musculation are absent in the casts.

These specimens came from what is probably the *Venango First Oil Sand* of the Pennsylvania geologists at Stone Hill near Stoneham, Pa. This species is closely related to no described species so far as we are aware. The very heavy concentric striæ of the right valve are sufficient characters to establish its separate position. It has somewhat the appearance of *L. halli* Herrick from the Waverly of Ohio, but both valves of our specimens are not equally heavily striated and our specimens are larger than *L. halli*.

The figure which most closely approaches our specimens in appearance is that of *Pterina lævis* as pictured by A. Hellman in Die Petrefacten Thüringens nach dem Materiale des Herzogl. Naturalien-Kabinets in Gotha. 1866, Pl. 17, fig. 47. Our species is, of course, not a *Pterinea* lacking, as it does, the internal characters of that genus.

### PEGASELLA, n. gen.

**Pegasella ales**, n. sp. Plate 25a, figs. 3-10.

Shell aviculoid; quadrilateral in outline; hinge-line straight; anterior portion slightly nasute; byssal sinus and front margin nearly perpendicular to the cardinal line; basal length nearly equal to cardinal length. Wing very large, frequently defined by a sulcus, but no fold present; apex of wing acute or attenuate, and often spiniferous in mature shell.

Ante-byssal portion small, nasute, defined by a well-marked byssal sinus; body broad at the base of the shell and acute at the apex; beak directed only slightly forward, located at the anterior part of the shell and elevated slightly above the hinge-line.

Surface marked by concentric varices which become fasciculate on the ante-byssal portion of the shell. Shell thin.

The height of the shell is individually variable, however the general features and relations are rather constant. More than a hundred specimens have been collected, all retaining both valves in place and preserved with the beak directed downward and the length perpendicular to the bedding planes of the sediment. They were evidently covered by sediment while boring in the sand. Due to the fragility of the shell few perfect specimens have been collected.

This genus (or sub-genus of *Avicula,* to use Frech's classification of the Aviculidæ) is of greater height and less obliquity than *Leptodesma.* The ante-byssal portion is nasute as in *Leptodesma* and not rounded or auriculate as in *Leiopteria.* In general outline, and especially in the broad portion of the shell *Pegasella* much resembles *Leiopteria.* No diaphragm separating the anterior portion of the shell from the cavity of the beak such as exists in *Leiopteria* has been found in *Pegasella.* Many specimens, especially if partially eroded, have an outline appearance very similar to some of the Silurian *Clionychia.* (See: Ulrich, E. O. Pal. of Minn., Vol. 3, pt. 2, pl. 35.)

*Occurrence.*—In the Oswayo sandstone one mile north of Olean Rock City, N. Y., at what was formerly known as Flat Iron station. The beds are best exposed in a cut along the highway. Associated with *Pegasella* were many *Camarotœchia allegania, Oleanella expansa, Athyris angelica,* and *A. lamellosa*(?) *Spirifer disjunctus, Crania* cf. *leoni, Orbiculoidea,* etc.

### PTERONITES

**Pteronites profundus** Hall Plate 46, figs. 2, 4, 6.

Pal. of N. Y., Vol. V, I, 1885, p. 237, pl. 22, figs. 25, 26, 27.

Size and appearance shown by illustration.

*Occurrence.*—The original description was based on material from the 'upper Chemung group' near Olean, N. Y., and in the vicinity of East Randolph and elsewhere in Cattaraugus county, N. Y.

**Pteronites rostratus** Hall Plate 46, fig. 3.

Pal. of N. Y., Vol. V, I, 1884, p. 238, pl. 22, fig. 24.

Size and appearance shown by illustration.

*Occurrence.*—The shales of the 'Chemung group' at Rockville, Allegany county, N. Y.

### PRORHYNCHUS Hall

**Geno-type: Palænatina quadrata** Hall

"Shell inequivalve the left valve the larger and more gibbous; inequilateral, subquadrate or rhomboidal. Anterior end truncate, angular, or nasute at the antero-dorsal extremity. Posterior end broad, margin truncate or broadly rounded. Beaks low, appressed, the umbo of the right valve somewhat gibbous and rising above the hinge-line. Cardinal line straight, extending entire length of the dorsal margin and alate at both ends. Umbonal slope sub-angular, extending to the post basal extremity; post cardinal slope with an often obscure or more or less defined fold along the middle of its area."

Surface marked with more or less regular, fine concentric striæ of growth.

Hinge-line (in the cast) marked by a groove indicating a strong lateral tooth or fold. There is also a groove along the hinge-line anterior to the beak and a divergent furrow extending toward the anterior margin. Ligament external. Single, large muscular impression present on the posterior basal portion of the umbonal slope. Pallial line, if present, undetermined.

This group was formerly placed among the 'Dimyarians' by Hall and in the family Palænatinidæ, but the discovery of a specimen (*P. Paneplanus*) with a single large muscular scar located in much the same position as in *Leptodesma* would seem sufficient to change this genus to the 'Monomyarians' and make it a member of the family *Aviculidæ*. The genus *Prorhynchus* is probably closely related to the genus *Leptodesma*.*

**Prohynchus quadratum** Hall Plate 40, fig. 16.
Plate 37, figs. 10-14.

**Prorhynchus quadratum** Hall, Pal. of N. Y., Vol. V, pt. I, 1885, p. 492, pl. 79, figs. 40-49; 94, fig. 5.

Shell large, inequivalve, quadrate; length usually more than one-third greater than the hight; byssal margin straight or gently rounded, curving upward in front. Posterior extremity almost vertically truncate. Cardinal line straight. Anterior end produced above, sub-nasute, obliquely truncate or gently rounded below.

Left valve depressed—convex below and becoming gibbous in the middle and especially in the umbonal region. Right valve depressed—convex, almost flat.

Beaks at about anterior third, appressed, rising but little above the hinge. Umbonal slope of the left valve obtusely angular, somewhat arcuate, extending to the post-inferior angle. Post cardinal slope broad and marked by a fold below the middle of its length.

The surface is marked by fine concentric striæ, the impressions of which are left on the casts of the interior.

The cast shows some striæ or grooves on the posterior portion of the cardinal line; anterior to the beaks there is a groove along the hinge and a narrow, divergent furrow, extending from the beak half way to the anterior margin.

Length of left valves varying from 19 to 45 mm., height from 12 to 28 mm. The right valves vary from 22 to 32 mm. in length and 13 to 17 mm. in height[35].

The characters of this shell are its sub-quadrate rhomboidal form, long, straight hinge-line and angular or nasute anterior extremity,

*Occurrence.*—Originally described from a coarse sandstone in the 'Chemung group' south of Smethport, Pa. This is prabably the sub-Olean sandstone. Specimens have also been collected at the same horizon at Glade, Pa.

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* The categories Monomyarian and Dimyarian have long since been shown to have little systematic value, but they still have a very useful descriptive application.

[35] Description taken from James Hall.

**Prorhynchus angulatum** Hall Plate 37, fig. 6.

**Prorhynchus angulatum** Hall, Pal. of N. Y., Vol. V, pt. I, 1885, p. 493, pl. 96, fig. 7.

Shell large, sub-rhomboidal; length and height as five to three; basal margin nearly straight, oblique to the hinge-line. Posterior extremity obliquely truncate, slightly sinuate in the middle. Cardinal line elongate, straight. Anterior end long, narrow, produced above, angular at the extremity and retrally truncate below, to the antero-basal angle.

Right valve depressed convex, slightly concave from the beak to the base in a broad undefined depression. Left valve unknown.

Beaks behind the anterior third, low and inconspicuous. Umbonal slope defined, prominent, extending to the post inferior angle, which is abruptly rounded, limited on the upper side by a distinct furrow, which produces a slightly sinuosity in the margin. Post-cardinal slope broad.

Surface marked by fine concentric striæ.

A specimen has a length of 53 mm. and a height of 30 mm. at the posterior end and of 20 mm. at the beak[35].

*Occurrence.*—In the upper part of the Chemung group at Warren, Pa.

**Prorhynchus harrisi,** n. sp. Plate 23, fig. 7.

Described from the mold of a left valve.

Shell large, sub-quadrate, rather inflated. Basal margin diverges posteriorly from a parallel condition with the hinge-line. The anterior margin is oblique with the cardinal line and the posterior margin is nearly perpendicular to the cardinal line and extends above it in a broad arc for 13 mm. This forms a wing-like attachment above the hinge-line making this species unique. This wing may extend anteriorly slightly farther than the illustrated specimen shows.

The umbo is slightly elevated, is broadly nasute and extends only a little above the cardinal line. The shell is most gibbous about the middle of the umbonal slope. A broad sinus extends almost vertically from the umbo to the basal margin of the shell and causes at its termination a broad sinuosity in that margin. This sinus separates the umbonal fold into an anterior or lesser fold which terminates in the anterior rotundity of the shell and a posterior or greater fold which has its terminus at the posterior basal angle.

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[35] Description from James Hall.

The surface is marked with fine concentric striæ of growth with an occasional one which is extra large. All of the striæ continue both on the ear and wing.

The cardinal line curves upward slightly at the front end and is gently rounded at the anterior angle of the 'ear'. The anterior portion is abruptly separated from the umbo by a steep anterior slope.

The mold shows the impression of a long lateral tooth along the hinge-line on each side of the beak. No trace of a ligamental area is preserved and no muscle scar or parallel sinus is present.

Dimensions:

| | |
|---|---|
| Length along hinge-line | 52 mm. |
| Perpendicular from umbo to base of shell | 31 mm. |
| Anterior margin | 23 mm. |
| Posterior margin to cardinal line | 32 mm. |
| Height of posterior wing above cardinal line | 11 mm. |

Strange though this alate species is, it has a modern counterpart in the form of some of our *Unionidæ;* among these are *Unio delphinus* Lea, *Symphonoia inflata* Lea, *Symphonota lævissima* Lea, *Unio housei* Lea, and *Unio cummingsi* Lea. All of these have a large alate growth above the cardinal line and the explanation of the function of this wing in the living forms is just as difficult as it is in the case of this fossil.

This species is probably rather closely related to *P. quadratum* Hall.

*Occurrence.*—At Stickley, Penna. In a light brown quartzitic sandstone, lying some feet below the Olean conglomerate and above a coarse ferruginous sandstone containing on abundance of *Camarotœchia allegania* Wms. The light brown standstone is thought to be the correlate of the Pelecypod bearing sandstone which occurs below the Olean conglomerate at 'Devils Den' near Smethport, Penna.

**Prorhynchus pæneplanus**, n. sp. Plate 23, fig. 5.

Species described from the internal mold of a right valve.

Shell quadrate in outline; anterior and posterior nearly parallel to each other and nearly normal to the cardinal line. The shell is widest posteriorly. The base margin is concave; this marks the end of a broad sinus. The cardinal line is straight. The umbo is situated anteriorly about two-thirds the length of the shell, and is slightly elevated above the cardinal line.

The shell is much flattened. A broad fold extends from the beak to the postero-basal angle. The crest of this fold is flattened near the beak but becomes concave as it nears the angle. A lesser fold extends from the beak across the beak to th median part of the hinder margin.

A shallow sinus extends along the base of the anterior umbonal slope to the basal margin where it widens considerably. A smaller sinus also exists between the fold on the wing and the main umbonal fold. This causes an invagination of the posterior margin where it terminates.

The surface was probably nearly smooth with poorly defined varices of growth over most of the shell and these becoming much heavier near the margin of the shell.

On the posterior-basal part of the umbonal fold there is a well-defined muscular impression.

Dimensions:

| | |
|---|---|
| Hinge-line | 42 mm. |
| Height (greatest) | 42 mm. |
| Anterior marginal elevation | 21 mm. |
| Perpendicular from beak to base | 25 mm. |
| Greatest width | 51 mm. |
| Hinge-line posterior to beak | 27 mm. |
| Greatest diameter of muscular scar | 17 mm. |
| Basal margin | 46 mm. |

This species differs from all the described species in the nearly equal in height and width, the well-defined muscle scar and the flat condition.

*Occurrence.*—The specimen described came from the fine-grained sandstone which lies just under the conglomerate (Olean) on the hill south of Smethport, Pa. The locality abounds in fragments of large *Leptodesma* and many fragments of *Prorhynchus.*

**Prorhynchus nasutum** Hall Plate 37, fig. 4.

**Prorhynchus nasutum** Hall, Pal. N. Y., Vol. V, pt. I, 1885, p. 493, pl. 96, fig. 6.

Shell of medium size, sub-rhomboid-ovate; length more than one-third greater than the height; byssal margin nearly straight, curving upward in front. Posterior extremity almost vertically truncate. Cardinal line straight. Anterior nasute above, rounded below.

Left valve depressed-convex in the lower part, gibbous in the upper and umbonal regions. Right valve depressed-convex, scarcely gibbous above.

Beaks anterior to the middle, appressed, incurved, scarcely elevated above the hinge-line in the left valve. In the left valve there is a broad undefined depression extending vertically from the umbo to the base. Umbonal slope obtusely angular and broad in the left valve, less conspicuous in the right, extending to the post inferior angle. Post cardinal slope broad, limited by a shallow longitudinal depression just above the umbonal ridge.

Surface marked by fine concentric striæ which are sometimes fasciculous.

The illustrated specimen has a length of 25 mm. and a height of 18 mm.; the length including the nasute anterior is 29 mm.[36]

*Occurrence.*—In the upper Chemung beds at Warren, Pa. Several specimens of this species have been found in the Conewango beds at Glade, Pa., though all are broken.

## OLEANELLA, new genus.

Type: **Ptychopteria expansa Hall**

**Oleanella expansa** (Hall) Plate 28, fig. 17.
Plate 30a, figs. 1-7.

**Ptychopteria expansa** Hall, Pal. of N. Y., V, I, 1885, p. 132, pl. 23, figs. 10, 11.

Aviculoid, hinge-line straight, wing large and undefined by a sulcus or fold; alar apex attenuate or acute; ante-byssal portion nasute and large, defined by a byssal sinus. Body narrow, attenuate at apex, mytiloid in general appearance and usually distinctly arched, thus creating an obviously convex posterior body margin.

The surface is radially plicate; the striæ on the anterior basal, and in some specimens on almost the whole anterior portion, abruptly geniculate, thus creating the appearance of two series of radii meeting acutely along the front umbonal angle. The striæ extend on both the anterior portion and the wing. Concentric striæ or varices intersect the radiating striæ and thus give the exterior of some specimens a fenestrated appearance. The varices become fasciculate anteriorly.

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[36] The specimens from Glade of this species are much larger and more nearly of the dimensions of **P. harrisi**

Upon examining the type specimen of J. Hall's *Ptychopteria expansa* we fail to find any extra wide intercostal space or overdeveloped rib which are mentioned as possible correlates of the ptychopteroid sinus and fold.

The genus differs from *Ptychopteria* in the rounded, narrow, attenuated body which is arched, the large undefined wing which terminates acutely, the large ante-byssal portion, coarser striæ, aviculoid outline of the mature shell and triangular shaped immature.

The specimen represented on Pl. 30A, figs. 5, 6, may be a varietal form of *O. expansa* for on this specimen the striæ are paired and such a development has not been observed on other specimens.

*Occurrence.*—J. Hall's specimen was found in a 'coarse sandstone of the upper Chemung group' near Smethport, Pa. The matrix in which the type is imprinted is identical with the Oswayo sandstone bearing many *Camerotœchia allegania* which is found at Smethport, Pa. That this is quite probably the type horizon is further substantiated by the fact that all of the other specimens found came from the Oswayo sandstone in a road cut at Flat Iron station one mile north of Olean Rock City, N. Y.

**Oleanella expansa, var. gamma,** n. var. Plate 30a, fig. 8.

This variety, if as such it endures, is characterized by unusually well-developed striæ. It is found in the Flat Iron station faunule.

**Actinopteria alpha** n. sp Plate 25, figs. 5, 6, 7.

Shell semi-quadrate, medium sized; slightly nasute anteriorly with a small ante-byssal portion and a very large wing. Surface radially plicate; radii indistinct. Weak concentric striæ also present. Greatest resemblance to *A. subdecussata* Hall but this is not remarkably close.

This species may be closely related to *A. beta,* occurring as they do in the same faunule, but from the material as yet discovered this relationship is not obvious.

*Occurrence.*—In a local, very thin conglomeritic layer in the shales about 10 feet above the Roosevelt Highway on the northern side of Smethport, Pa. The matrix is of a dark brown color with an abundance of light quartz pebbles and the fossils are all stained a rufous limonitic brown. Formation possibly Conewango.

**Actinopteria beta,** n. sp. Plate 25, fig. 8.

Transverse, winged; posterior cardinal extremity attenuate; anterior unknown but probably nasute and narrow. Surface with large radial costæ which are best developed on the umbonal fold and are much finer on the wing. Other characters shown by the illustration.

*Occurrence.*—See *A. alpha,* above.

**Actinopteria** sp. **undet** Plate 25, fig. 4.

From the Panama conglomerate at Checkered School House near Panama, N. Y., a medium sized specimen of *Actinopteria* of undetermined species was obtained. The specimen is in the form of an internal mold.

The shell is transversely subquadrate with a straight hingeline which is the greatest width of the shell. The basal margin is only slightly rounded and nearly parallel to the cardinal line. The anterior margin curves gently on the basal-anterior angle and extends obliquely almost straight to the hinge line, and is only slightly convex where it bounds the small ear. The posterior margin is broadly rounded and meets the cardinal line obliquely.

The wing occupies about one-half the shell surface. The umbo is anterior and is elevated a little above the hinge line. The shell is most gibbous on the anterior half of the umbo. The ear is nearly obsolete.

On the posterior slope of the umbo slight radial plications are visible. Over the whole shell concentric plications of low relief are present.

Were is not for the slight radial plications this species would be almost an exact replica of *Leiopteria ortoni* Herrick. There is a slight similarity in general shape between this species and *A. perobliqua* (Con.) as pictured and described in Pal. N. Y. Vol. V, Pt. I. It also has much in common with *A. boydi* Hall and may be referred to this species when more and better material has been found.

## PTYCHOPTERIA Hall

The genus *Ptychopteria* is characterized by a nasute anterior end, a large straight margined wing which has a well defined fold and is separated from the umbo by a depression. The surface is radially striate.

The general shape of the shell is not particularly characteristic, for several of the aviculoids, especially *Leptodesma* may have the same general appearance. It is the striate surface which really establishes the identity of this genus.

James Hall described twenty-two species of *Ptychopteria* in the *Paleontology* of *New York*. The type specimens of several of these species show only a few very slight differences and in as much as they were often described from the same horizon a real question arises as to the specific value of these differences.

This genus seems to be restricted to the Conewango beds of western New York and Pennsylvania. One very doubtful species of this genus was described from the Ithaca beds of Maryland in the Maryland Geological Survey.

**Ptychopteria proto** Hall Plate 28, figs. 1, 5, 6.

Pal. of N. Y. vol. v, i, 1884, p .129, pl. 23, figs. 12, 14.

The anterior end is large and rounded, the wing small and triangular and the byssal sinus broad. The striæ are fine.

The larger anterior end, less sinuate basal margin and slightly coarser striæ seem to separate this species from *P. sinuosa,* to which it is closely related. *P. proto* was originally found in loose material at Portville, N. Y., and in a coarse sandstone of the 'upper Chemung' at Smethport, Pa.

**Ptychopteria sinuosa** Hall Plate 28, fig. 2.

Pal. of N. Y. V, I, 1884, p. 130, pl. 23, fig. 13; pl. 85, fig. 8.

This species is characterized by a large narrow anterior portion, a narrow wing and broad byssal sinus. It is very closely related to *P. proto* though according to James Hall, the smaller anterior end, and coarser striæ, are sufficient to separate them.

This species is associated with *P. proto* in a coarse sandstone of the 'upper Chemung' at Smethport, Pa., and at Warren, Pa., where it was associated with *Spirifer disjunctus.*

**Ptychopteria salamanca** Hall Plate 30, figs. 14, 15, 16.

Pal. of N. Y. Vol. I, 1884, p. 131, pl. 23, figs. 17-20.

The illustrations show the characters of the species. It may be that this species is only a smaller form of *P. beecheri* (and *spatulata*).

The type locality is a sandstone above the Salamanca conglomerate at Rock City, near Salamanca, N. Y.

**Ptychopteria lobata** Hall Plate 29, fig. 9.

Pal. of N. Y. Vol. I, 1884, p. 150, pl. 85, fig. 37.

This is a small species, the most characteristic thing about which is the unusually strong alar fold.

This species was found orignally in the 'upper Chemung group' at Warren, Pa.

**Ptychopteria gibbosa** Hall Plate 29, fig. 8.

Pal. of N. Y. Vol. V, I, 1884, p. 149, pl. 85, fig. 5.

The centrally located and prominent beak, the attenuate anterior portion of the shell, the large byssal sinus and strong fold and furrow of the wing characterize this rather small *Ptychopteria.*

It is found in the beds of the 'upper Chemung' at Warren, Pa.

**Ptychopteria vanuxemi** Hall Plate 29, fig. 17.

Pal. of N. Y., V, I, 1884, p. 151, pl. 85, fig. 36.

This is one of the most specialized forms of *Ptychopteria.* It approaches the genus *Pteronites* in its general appearance, as James Hall pointed out in his original description.

The type locality is the highest beds of the 'Chemung group' at Warren, Pa.

**Ptychopteria trigonalis** Hall Plate 28, fig. 9, 10.
Plate 27, fig. 10, 1.

Pal. of N. Y. Vol. V, I, 1884, p. 140, pl. 85, fig. 34, 35.

The most noticeably characters of this species are the large triagonal shaped wing which is well delimited in the immature forms and less distinctly delimited in the mature, and the truncate rear margin.

There is some resemblance between this species and *P. falcata* and *P. alata* and when more well preserved specimens are found *P. trigonalis* will probably be referred to one of these species.

The type locality for this species is the sandy shale above the Panama conglomerate at Panama, N. Y. Several imperfect specimens have been found at Pope Hollow, N. Y., which were referred to this species.

**Ptychopteria falcata** Hall Plate 29, fig. 6, 7.

Pal. of N. Y. Vol. V, I, 1884, p. 136, pl. 85, fig. 6, 7.

**Ptychopteria galene** Hall Plate 29, fig. 12, 13, 14.

Pal. of N. Y. Vol. V. I, 1884, p. 142, pl. 85, fig. 29-31.

**Ptychopteria perlata** Hall Plate 29, fig. 4, 5.

Pal. of N. Y. Vol. V, I, 1884, p. 147, pl. 85, fig. 38, 39.

**Ptychopteria thalia** Hall Plate 29, fig. 10, 11.

Pal. of N. Y. Vol. V, I, 1884, p. 148, pl. 85, fig. 32, 33.

The characters of the species are shown sufficiently well by the illustrations. They are probably all very closely related, but the types have not been examined.

*P. thalia* and *falcata* come from the 'Chemung group' at Allegany Springs, Warren County, Pa.

*P. galene* and *perlata* come from the 'upper Chemung' at Warren, Pa. *P. perlata* is reported by Chas. Butts from above the Salamanca conglomerate[1].

*P. lata* comes from the middle of the 'Chemung series' which is exposed at Warren, Pa.

**Ptychopteria alata** Hall Plate 28, fig. 11-15.
Plate 26, fig. 8.
Plate 27, fig. 7, 8.

Pal. of N. Y. Vol. V, I, 1884, pl. 85, fig. 26, pl. 23, figs. 21, 22, 25, 26.

The left valve is most gibbous, angular and elevated from the umbo to the posterior extremity. The right valve is most alate. The other characters are shown by the illustrations which are natural size.

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[1] N. Y. State Mus. Bul. 69, p. 994.

This species was described from a coarse sandstone of the 'Chemung group' near Salamanca, N. Y. Several of the specimens illustrated came from the Lamellibranch series[2] at Pope Hollow, Pa.

**Ptychopteria beecheri** Hall
Plate 29, fig. 1, 15, 16.
Plate 27, fig. 1-4, 9.
Plate 26, figs. 2, 4, 5, 7, 9.

Pal. of N. Y. Vol. V, I, 1884, p. 143, pl. 85, figs. 21, 22
**Ptychopteria spatulata** Hall
Pal. of N. Y. Vol. V, I, 1884, p. 144, pl. 85, fig. 20.

*P. beecheri* and *P. spatulata* are most certainly the same species as even a reference to the orignal illustrations will show. After studying many specimens which conform equally well to either 'species' it seems quite certain that the two are identical. Since *P beecheri* was the form first described the species should be known by this name.

Both forms were originally described from the 'upper Chemung' group at Warren, Pa. Many specimens of this species have also been found in the brown sandstone at Glade, Pa.

**Ptychopteria eucrate** Hall
Plate 28, fig. 3.
Plate 30, figs. 7-13.
Plate 26, fig. 3.
Plate 27, fig. 5, 6.

Pal. of N. Y. Vol. V, I, 1884, p. 133, pl. 85, fig. 27, 28; pl. 23, fig. 24.
**Ptychopteria elongata** Hall
Pal. of N. Y. Vol. V, I, 1884, p. 141, pl. 85, figs. 10-14.
**Ptychopteria eudora** Hall
Pal. of N. Y. Vol. V, I, 1884, p. 138, pl. 85, fig. 9.

This species is usually narrower than *P. sao,* some forms of which seem to approach this species, and some forms are apparently intermediate between *P eucrate* and *P. alata.*

There seems to be no good reason for attempting to distinguish between the species *P. eucrate, elongata,* and *eudora* of Hall. The species *P. eudora* is represented by a single type specimen which seems to hold an intermediate position between the types of *P. elongata* and *P. eucrate.* These differences are probable only indivdual fluctuations.

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[2] See G. D. Harris, Am. Geol. Mar. 1891, p. 164.

This species (and synonyms) was orignally described from the Panama conglomerate at Panama, N. Y. Specimens have also been collected at the same horizon at Checkered School House near Panama. Several specimens which were referred to this species were also found at Glade, Pa., from what is probably a slightly higher stratigraphic position. C. Butts reports *P. elongata* from the Wolf Creek conglomerate[37].

**Ptychopteria sao Hall** Plate 30, figs. 1-6.
Plate 25, fig. 9.
Plate 28, figs. 7, 8, 16, 18.

Pal. of N. Y., Vol. V, I, 1884, p. 133, pl. 23, fig. 16; pl. 85, fig. 14-18.
**Ptychopteria thetis Hall**
Pal. of N. Y. Vol. V, I, 1884, p. 135, pl. 85, fig. 1-4.
**Ptychopteria spio Hall**
Pal. of N. Y. Vol. V, I, 1884, p. 137, pl. 85, fig. 19.

The species of *Ptychopteria* which prevails in the Panama conglomerate is of the *P. sao* type. The species is extremely variable within rather definite limits, and several of these variations, which are only a few of the many, have been given specific names. There are a few forms of Ptychopteria which are associated with *P sao* which seem to be intermediate between *P sao* and *P. eucrate,* as described herein.

The species is present in abundance in the Panama conglomerate and was originally described from that horizon at Panama, N. Y.

(?) **Ptychopteria obsoleta** Simpson Plate 37, fig. 3.
**Ptychopteria obsoleta** Simp. Tr. Am. Phil. Soc. ns. 16, 1888, p. 448, il.

*Simpson's description (abbreviated).*—

Shell of medium size, subrhomboidal in outline; body ovate-oblique, at an angle of about 40 degrees to the hinge-line; height about three-fourths the length. Anterior margin abruptly rounded; basal margin curved outward to the extremities, concave at the middle; posterior margin somewhat abruptly recurved.

Right valve unknown. Left valve moderately convex; greatest convexity at the umbonal region. Hinge-line straight; length sub-equal to the greatest width of shell. Anterior extremity acute, margin rounded.

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[37] Bu. N. Y. State Mus. no. 69, p. 994.

Wing triangular, margin sigmoidal. Wing convex, flattened immediately below the cardinal line; separated from the body by a narrow but conspicuous depression.

Surface ornamented by faint radiating striæ, which are obsolete except on perfectly preserved specimens. Concentric striæ also present these becoming fasciculate anteriorly.

Note:

This species seems to be closely related to *Leptodesma parallelum* Simp. and possibly *Prorhynchus quadratum* which it very much resembles in outline. It has the ptychopteroid alar sinus and fold in addition to these other characters. It probably belongs to no genus at present defined though its relationship seems obvious even from the illustration. It is such a transition form as might be expected among these upper Devonian aviculoids.

*Locality.*—Chemung group, hill north of Warren, Pa.

## MYTILARCA

Equivalve, inequilateral, mytiliform; beaks terminal; hinge short; ligamental area striated; cardinal teeth beneath the beak small, oblique; posterior teeth small, oblique, and at the extremity of the hinge; anterior muscle scar umbonal, and posterior one near the postero-basal margin; pallial-line entire, simple; surface not infrequently with fine obscure radiating striae.—From Miller.

**Mytilarca chemungensis** Hall Plate 39, fig. 1-6.

Pal. of N. Y., Vol. V, I, 1884, p. 258, pl. 32, figs. 8-11, 13, 14.

*Occurrence.*—Middle of the 'Chemung group' which is exposed at Rockville, Phillipsburg, Allegany county, N. Y., and at East Randolph, and in the 'Upper Chemung' beds at Warren, Pa.[38]

**Mytilarca regularis** Hall Plate 38, fig. 13.

Pal. of N. Y. Vol. V, I, 1884, p. 260, p. 32, fig. 12.

*Occurrence.*—In the sandstone of the 'Chemung group' near Leon Center, Cattaraugus county, N. Y.

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[38] Prosser, Bul. Geol. Surv. of Ohio, No. 15, p. 460.

**Mytilarca simplex Hall** Plate 38, figs. 6, 8.

Pal. of N. Y., Vol. V, I, 1884, p. 261, pl. 33, figs. 19, 21.

*Occurrence.*—In the sandstone of the 'Chemung group' west of Smethport, Pa., and reported from the Oswayo by C. Butts.[39]

**Mytilarca gibbosa Hall** Plate 39, figs. 4, 5.
Plate 41, fig. 14.

Pal. of N. Y., Vol. V, I, 1884. p. 262, pl. 33, fig. 20; pl. 87, fig. 7.

*Occurrence.*—In the upper Chemung group at Napoli, Cattaraugus county, N. Y. Several specimens referred to this species have also been found at Stone Hill, southeast of Warren, Pa. in the upper Conewango beds.

**Mytilarca lata Hall** Plate 38, fig. 10.

Pal. of N. Y. Vol. V, I, 1884, p. 262, pl. 3, fig. 22.

*Occurrence.*—In the 'Chemung group' at Randolph, Cattarugus county, N. Y.

**Mytilarca occidentalis Hall** Plate 39, figs. 6, 7, 3.

Pal. of N. Y. Vol. V, I, 1884, p. 263, pl. 33, figs. 3-5; pl. 87, fig. 11.

*Occurrence.*—Originally described from the yellow sandstone of Burlington, Ia. Reported from the Panama conglomerate in Erie county, Pa., by J. P. Lesley.[40] One specimen from the Conewango formation two miles north of Warren, Pa., has been referred to this species.

## MODIOLA

Resembles *Mytilus,* true *Modiola* and *Lithodomus* in general features. Hinge-line narrow, oblique, extending about half the length of the shell, beaks terminal—*emend* Miller.

**Modiola (Mytilops) praecedens Hall** Plate 23, figs. 1, 3, 6.
Plate 38, figs. 1-5, 11, 12.
Plate 40, figs. 7, 8.

Pal. of N. Y., Vol. V, I, 1884, p. 267, pl. 33, figs. 9-18.

*Occurrence.*—In a conglomerate of the 'Chemung group' at

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[39] Butts, Bul. N. Y. State Mus., No. 69, p. 995.

[40] Pa. Geol. Surv. **Dict. of Fossils,** p. 437.

Portville, N. Y., and southeast of Smethport, Pa. Specimens have also been taken at Bradford, Pa. in a conglomerate; some of these are shown on plate 40. *M. præcedens* is also reported by C. Butts from the Wolf Creek conglomerate[11].

**Modiola (Mytilops) metella** Hall Plate 42, figs. 1, 8.
Plate 38, figs. 7, 9.

Pal. of N. Y. Vol. V, I, 1884, p. 268, pl. 33, figs. 23, 24; pl. 87, fig. 9.

*Occurrence.*—In the Panama conglomerate at Panama, N. Y., and in a boulder of simlar rock on the road from Ellington to Cherry Creek, Chautauqua county, and at Warren, Pa. Specimens which have been referred to this species but which are nearly intermediate in general appearance of the internal molds between this species and *M. præcedens* were collected in a conglomerate at Bradford, Pa.

## MODIOMORPHA

Equivalve, sub-ovate, larger posteriorly, compressed; beaks small; sinus oblique and constricting the base; surface concentrically undulated; single tooth in the left valve, and corresponding in the other; no lateral teeth; ligament external.—From Miller.

**Modiomorpha rigida** Hall Plate 43, figs. 1-3.

Pal. of N. Y. Vol. V, I, 1885, p. 287, pl. 41, figs. 14-16.

*Occurrence.*—In the sandstone of the 'Chemung group' near Angelica and Rock Creek, Allegany county, N. Y.

**Modiomorpha quadrula** Hall Plate 43, figs. 4-8.

Pal. of N. Y. Vol. V, I, 1885, p. 289, pl. 41, figs. 18-26.

*Occurrence.*—In the micaceous shales of the 'Chemung group' at Belmont and Rockville, in Allegany and Cattaraugus counties, N. Y.

## PALEONEILO

Nuculiform, posterior end extended, sulcus along the umbonal slope; surface concentrically striated or ribbed; hinge-line arcuate, crenulate, not interrupted beneath the beak by a ligamental pit; ligament external; anterior and posterior muscle scars distant; pedal scars within the umbonal cavity.—From Miller.

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[11] Bul. N. Y. State Mus. No. 69. p. 993.

**Paleoneilo elongata** Hall Plate 39, figs. 15, 16.

Pal. of N. Y. Vol. V, I, 1885, p. 345, pl. 48, fig. 39; pl. 93, fig. 11a.

*Occurrence.*—In the shales of the 'Chemung group' at Phillipsburg, Allegany county, N. Y., and at Warren, Pa.

**Paleoneilo** sp. Plate 40, fig. 12.

A small specimen of *Paleoneilo* measuring 12.5 mm. in length and 9 mm. in height was found at Bradford, Pa. in the shales of the upper Chemung. It has a broad posterior sulcus which extends above the umbonal fold from the beak to the margin of the shell. The enlarged picture shows nearly all the characters of the shell. The specific relationship of this form can hardly be determined from this imperfect specimen.

## NUCULA

Equivalve, inequilateral, oval, or oblong, closed all around, without external ligamentary facets; beaks directed backward; cartilage internal; placed in a pit under the beak; teeth numerous, very long.—From Miller.

**Nucula globularis** Hall Plate 36, fig. 16.

Pal. of N. Y. Vol. V, I, p. 322, pl. 93, fig. 6.

*Occurrence.*—In the Panama conglomerate at Panama, N. Y., where it is associated with *Ptychopteria sao* and *Spirifer disjunctus* and at Warren, Pa.

**Nucula (?)** sp. Plate 41, fig. 6.

From the middle Conewango beds at Glade, Somerset county, Pa., a specimen of undetermined affinities was found. In outline it is rather nuculoid, with a slight resemblance to *Yoldia*. However, all internal characters are unknown and while this is quite probably an undescribed form its description must await the discovery of more specimens.

## GRAMMYSIA

Equivalve, inequilateral; shell thick, oblong; anterior side short, contracted by a deep oval lunette beneath the beak; posterior end elliptically rounded; hinge-line straight; two large adductor impressions in each valve, anterior rounded, posterior pear-shaped; pallial scar entire; cartilige external, short, in the anterior part of a deep depression formed by the inflexion of the hinge margins; an oblique furrow extends from beak to about the middle of the ventral margin.—From Miller.

**Grammysia communis** Hall Plate 45, figs. 7-10.

Pal. of N. Y. Vol. V, I, 1885, p. 378, pl. 61, figs. 24-28; pl. 93. fig. 20.

*Occurrence.*—In the 'Chemung group' at New Albion, Olean, Portville, and Little Genesee and at Warren, Pa. At the latter locality this species is in the upper Chemung, beds according to Prosser.[42]

**Grammysia undata** Hall Plate 45, figs. 3, 4.

Pal. of N. Y. Vol. V, I, 1885, p. 379, pl. 51, fig. 23; pl. 64, fig. 30; pl. 93, fig. 21.

*Occurrence.*—In the Panama conglomerate at Panama, N. Y., and in the same formation 4 miles north of Panama; at the same horizon at Allegany Springs, Warren county, Pa., and in sandy shales near Salamanca and Portville, N. Y.

**Grammysia duplicata** Hall Plate 45, fig. 2.

Pal. of N. Y. Vol. V, I, 1885, p. 380, pl. 93, fig. 23.

*Occurrence.*—In the upper beds of the 'Chemung group' at Warren, Pa.

**Grammysia (?) subnasuta** Hall Plate 45, fig. 5.

Pal. of N. Y. Vol. V, I, 1885, p. 507, pl. 64, figs. 5, 6.

*Occurrence.*—In a coarse sandstone or conglomerate of the 'Chemung group' at Portville, N. Y.

**Grammysia (?) glabra** Hall Plate 45, fig. 6.

Pal. of N. Y. Vol. V, I, 1885, p. 369, pl. 93, fig. 24.

*Occurrence.*—In the upper standstones of the 'Chemung group' at Warren, Pa., and doubtfully at Clark's farm, near Panama, N. Y.

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[42] Bul. 15. Ohio Geol. Surv. p. 460.

## SPHENOTUS

Equivalve, very inequilateral, elongate; anterior end short; posterior end obliquely truncate; cardinal line long, straight; umbonal ridge extending to the posterior extremity; surface concentrically lined; two short teeth beneath the beak of the right valve, and one or two slender lateral teeth; ligament external, contained in a groove; anterior muscular scar strongly marked; posterior scar shallow; pallial line simple.—From Miller.

**Sphenotus contractus Hall** Plate 44, figs. 2, 3, 9-12, 14-17.
Plate 42, fig. 4.

Pal. of N. Y. Vol. V, I, 1885, p. 399, pl. 66, figs. 1, 3-9, 11-13, 15; pl. 94, fig. 2.

This is probably the most common *Sphenotus* in western New York and Pennsylvania. There is a great deal of individual variation in the species, but they nearly always have a well marked longitudinal carina along the middle of the post-cardinal slope.

*Occurrence.*—In the 'Chemung group' at Phillipsburg and Rockville, Allegany county, N. Y.; near Olean and Randolph, Cattaraugus county, N. Y.; near Ellington and north of Panama, N. Y., and at Warren and Allegany Springs, Pa. Above the Salamanca conglomerate[43].

**Sphenotus clavulus Hall** Plate 44, figs. 3, 7, 13.
Plate 42, fig. 5.

Pal. of N. Y. Vol. V, I, 1885, p. 401, pl. 66, fig. 2, 20-26.

This form usually has no fold on the post-cardinal slope though it may have an obscure one. Other specific characters are shown by the pictures.

*Occurrence.*—In the 'Chemung group' at Phillipsburg and in loose masses of sandstone near Portville and Olean, N. Y. It is rather common in the Conewango beds. It is mentioned by Butts as occurring in the Wolf Creek conglomerate and by Prosser from the 'Riceville' formation of Meadville, Pa[44].

**Sphenotus arcuatus Hall** Plate 44, fig. 19.

Pal. of N. Y. Vol. V, I, 1885, p. 400, pl. 66, fig. 18.

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[43] Bul. N. Y. State Mus. No. 69, p. 994.
[44] Bul. Ohio. Geol. Surv. No. 15, p. 407.

*Occurrence.*—Originally described from the Panama conglomerate east of Panama, N. Y., and listed by Butts from the Wolf Creek and Salamanca conglomerates.

**Sphenotus signatus** Hall Plate 44, fig. 1.

Pal. of N. Y. Vol. V, I, 1885, p. 405, pl. 94, fig. 3.

*Occurrence.*—From the Waverly beds at Warren, Pa.

**Sphenotus palmeræ** n. sp. Plate 42, figs. 9, 10.

Shell of medium size, Sphenotoid in outline. Seems to most resemble *S. clavulus* in mass proportions.

The most outstanding character of this species is a much elevated ridge along the umbonal fold. This carina is much more strongly developed than in the usual *Sphenotus.* The carina is lower on the left valve than on the right, thus making the post-umbonal area of the left valve somewhat larger than that of the right. Both valves are of about equal size and gibbosity.

On the upper part of the post-umbonal area of each valve there is a second carina which is close to and parallel to the cardinal line.

The narrow dorsal (cardinal) surface of each valve, posterior to the beak, is flattened and lunule-like.

The surface is concentrically striate both on the anterior and posterior-umbonal regions.

The illustrations are one and a half times natural size.

This species is named for Dr. K. V. W. Palmer, research assistant in the Paleontology laboratory at Cornell University.

*Occurrence.*—In the Conewango formation one hundred feet above the road level at Glade, Pa. The matrix is a light brown quartzitic sandstone.

## GONIOPHORA

Equivalve, very inequilateral, rhomboidal or trapezoidal, obliquely truncate behind, rounded in front; cardinal line straight; beaks small, umbo prominent, and slope continued as a ridge to the post-inferior margin; oblique undefined sinus from anterior of the beaks to the basal margin; surface concentrically lined; hinge with an oblique fold or tooth in the left valve beneath the beak, and a corresponding depression in the right valve; ligament external attached by one or more grooves; anterior muscular impression deep, situated anterior to the beak; Posterior muscular impression shallow, situated on the posterior cardinal slope; pallial line simple.—From Miller.

**Goniophora (?) curvata** Simpson Plate 46, fig. 7.
Tr. Am. Phil. Soc. ns. 16, 1889, p. 451.

This is probably a form of *Sphenotus* rather than a true *Goniophora.*

*Occurrence.*—The 'Chemung group' north of Warren, Pa.

**Goniophora ruedemanni** n. sp. Plate 25a, figs. 12, 12a, 13.

Shell trapezoidal, large; cross-section nearly square; left valve with beak anterior, incurving, depressed; umbonal ridge very angular, extending from apex of beak to post-inferior margin in a broadly sinuate manner; post-umbonal portion larger than ante-umbonal portion with a low secondary sulcus extending from the beak to mid posterior margin and approximately bisecting the area; posterior margin nearly normal to the hinge-line; ante-umbonal portion with a broad sinus which is inferiorly expressed in a sweeping sinuosity; the portion of the shell in front of the beak almost entirely occupied by a large oval impressed adductor muscle scar; retractor muscle scar small, distinct, above the adductor and just under the beak; hinge-line straight; ligament external; one short anterior lateral tooth and a long well defined posterior lateral tooth present; surface with faint varices of growth.

The nearly vertical posterior margin, strong posterior lateral tooth, secondary post-umbonal sulcus and general contour differentiate this shell from any heretofore described species.

*Occurrence.*—In the Oswayo shales near the crest of Olean Rock City hill, at a place formerly known as Flat Iron Station. Usually found in life-like positions: normal to the bedding planes. Associated with an abundant and characteristic fauna; *Athyris angelica, Spirifer disjunctus, Camarotœchia allegania, Pegasella ales, Oleanella expansa, Leptodesma* sp. etc.

### EDMONDIA

Shell equivalve, inequilateral, tumid, short, oblong or rounded, closed all around; dorsal and ventral margins slightly convex; beaks tumid with an appressed lunette between them; surface with concentric striae; no teeth, but an internal lamellar cartilage support, much dilated within the cavity of the beaks, the broad end forming the slits in casts coinciding with the edges of the anterior lunette, and the posterior end running nearly parallel to and close within the hinge-line; dorsal margins erect and simple; two simple adductor impression often with an accessory impression over each, pallial scar simple, entire.—From Miller.

**Edmondia rhomboidea** (Hall) Plate 36, fig. 9.

Pal. of N. Y. Vol. V, I, 1885, p. 386, pl. 64, figs. 7, 8.

*Occurrence.*—In a sandstone of the 'Chemung group' at Salamanca, N. Y., and four miles north of Panama, N. Y.

**Edmondia phillipi** Hall Plate 36, figs. 4-8.

Pal. of N. Y. Vol. V, I, 1885, p. 387, pl. 64, figs. 9, 11-14, 17, 29; pl 95; figs. 1-4.

*Occurrence.*—In the shales of the 'Chemung group' at Phillipsburg and Rockville and in the sandstone of Hobbieville and Conewango, N. Y. and in the shales of Mansfield, Pa.

**Edmondia transversa** Hall Plate 36, fig. 10.

Pal. of N. Y. Vol. V, I, 1885, p. 387, pl. 94, fig. 24.

*Occurrence.*—In the sandstone of the 'Chemung group' at Cold Spring, Cattaraugus county, N. Y. and doubtfully near Olean, N. Y.

**Edmondia (?) subcarinata** Hall Plate 36, fig. 11.

Pal. of N. Y. Vol. V, I, 1885, p. pl. 64, fig. 31.

*Occurrence.*—The 'Chemung group' near Olean, N. Y.

### PARARCA Hall

The shells of this genus are equivalve, inequilateral, and transversely subelliptical or rhomboidal; the anterior end is short and rounded; the cardinal line is crenulate and arched at the beak. The surface is radially and concentrically plicate, the radial plications are usually fine[45].

The members of this genus are mostly upper Devonian or

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[45] Generic description in part from Miller, North Am. Geol. and Pal.

Waverly in their distribution and are relatively common in fragmentary condition especially in the coarse sandstone and conglomerate lentils of northwestern Pennsylvania and south western New York.

**Pararca venusta** Hall Plate 37, fig. 2.

Hall, Pal. N. Y. Vol. V, pt. I, 1885, p. 431, pl. 94, fig. 24.

Shell large, broadly eliptical; length slightly greater than the height; basal margin gently and regularly curving. Posterior extremity broadly rounded. Cardinal line short and slightly arcuate. Anterior end short, regularly rounded below the lunule.

Valves regularly convex in the lower and posterior parts and gibbous in the middle and above.

Beaks sub-anterior and not prominent. Umbonal slope not defined, the line of greatest convexity arcuate and continuing from the beak to the post inferior extremity.

Surface marked by numerous fine rounded radi with narrower interspaces, the radii of the anterior end being stronger as they approach the margin of the shell; crossed by fine concentric lamellose striae, which toward the margin become fasciculate and produce stronger varices of growth.

Length 39, 43 mm.; height 31, 32 mm.

The species resembles *P. sao* in general form but is proportionally narrower posteriorly and marked by finer radii.

*Occurrence.*—In the upper part of the 'Chemung group', at Warren, Pa.; at Panama, N. Y. above the conglomerate.

**Pararca neglecta** Hall Plate 37, fig. 5.

Hall, Pal. N. Y. Vol. V, pt. I, 1885, p. 432, pl. 70, fig. 13.

Shell small, broadly sub-elliptical; length one-third greater than the height; basal margin regularly curved. Posterior extremity broadly rounded. Cardinal line straight, about half the length of the shell. Anterior end short, regularly rounded below the lunule.

Valves depressed convex below, becoming moderately convex in the umbonal region, somewhat flattened in the middle below the center.

Beaks at about the anterior third of the shell, low rounded, rising but little above the hinge-line. Umbonal slope undefined.

Surface marked by numerous fine rounded radii which are much stronger at the anterior end. Interspaces much narrower than the radii. Entire surface also marked by strong, regular, undulating concentric lines.

This species is distinguished from *P. transversa* by its broader and less gibbous form, coarser radii, coarser and regular concentric striae, and undefined umbonal slope.

*Occurrence.*—In the sandstones of the Waverly group at Meadville, Pa.

**Pararca sao Hall** **Plate 37, fig. 1.**

Hall, Pa. of N. Y. Vol. V, pt. I; 1885, p. 430, pl. 70, fig. 17.

Shell large broadly elliptical; length less than one-third greater than the height; basal margin regularly curving. Posterior extremity obliquely sub-truncate. Cardinal line slightly arcuate. Anterior end short and regularly rounded below the lunule.

Valves regularly convex below, becoming gibbous in the middle and in the umbonal region.

Beaks sub-anterior, moderately prominent and incurved. Umbonal slope convex, not strongly defined, extending in an arch direct to the post basal extremity.

Surface marked by numerous strong, rounded plications. Those on the anterior basal margin are much stronger than those on the posterior half of the shell. Interspaces narrower than the radii. All the plications except those of the anterior end are arcuate, corresponding essentially with the direction of the umbonal slope. Entire surface marked by fine concentric striae of growth.

Two specimens measured respectively 45 and 50 mm. in length and 32 and 37 mm. in height.

This species somewhat resembles in form *P. transversa* but it has a much larger shell, the radii coarser and the umbonal slope not nearly so abrupt.

*Occurrence.*—In the 'Chemung group' at Meadville, Pa. associated with *Spirifer disjunctus;* also found near Uniontown, Pa.

**Pararca erecta** Hall Plate 42, fig. 6.

Hall, Pal. N. Y. Vol. 5, pt. I, 1885, p. 432, pl. 70, fig. 16; pl. 94; figs. 20, 21.

Shell quadrilateral; height and length nearly equal; hinge-line arched. Cardinal line at least one-half the width of the shell. Basal margin regularly rounded, curves abruptly to anterior and posterior margins. The anterior margin is shorter than the posterior, regularly rounded to the cardinal line; posterior margin slightly convex, almost vertical.

Gibbosity slight, greatest on the umbo. Shell depressed along the median line, from the umbo to the basal margin. Beak at about the anterior third, much elevated, prominent and abruptly incurved. Anterior umbonal slope very abrupt; posterior slope more gradual.

Surface sculpture consists of numerous fine, rounded, closely spaced radii. The posterior radii are coarser than the mesial ones and those on the anterior portion of the shell are much larger and farther apart than those of either of the other two series. Inconspicuous concentrically undulating striae are also present. These become fasciculate and cause lines of growth on the lower and anterior portions of the shell.

Ligamental area narrow and the hinge line crenulate.

Length varies from 22 to 28 mm. and the height from 20 to 36 mm.

Our specimens are smaller than those described by Hall and constitute the minimum in the above description. The beaks of our specimens are much more elevated than those of any of the specimens pictured by Hall.

This species is characterized by its erect rhomboidal form, and nearly equal length and height. The radii are finer than in *P. venusta.*

*Occurrence.*—The species was originally described from the Waverly group at Warren, Pa. and Meadville, Pa. Our material came from the Panama conglomerate at the ledge near the 'Checkered School House'.

## SPIRODOMUS

**Spirodomus insignis** Beecher Plate 59, figs. 1, 2.

39th Rep. N. Y. S. Mus. of Nat. Hist. 1886, p. 162, pl. 12, figs. 1-5.

Beecher's original description: "Shell cylindrical, longitudinally spiral or twisted, the margins making nearly a complete volution; length nearly three times the breadth. Ventral margin entire, curved. Dorsal margin of the same curvature as the ventral border. Hinge-line extremely short or obsolete.

"Valves compressed posteriorly, gibbous along the middle and anterior portions. The transverse section of the two halves in position, in the middle of their length, is broadly elliptical. The greatest depth of both valves is in the anterior third.

"Beaks terminal, small and appressed, situated in the middle of the anterior end. Umbo not prominent.

"Test thin. Surface marked by very fine striae of growth. Ventral and dorsal margins strongly crenulate, produced in a thin reflexed expansion. Posterior margin simple, slightly bent.

"The cast of the interior is marked by a small, distinct pit or depression at the anterior extremity, and just below is, apparently, a small muscular scar. The upper part of the posterior muscular impression, in the cast, is marked by two or three nodes, from which a low rounded ridge extends anteriorly about one-third the length of the shell and then becomes merged in the general convexity of the valve. This ridge was probably produced in the recession of the muscular scar consequent on the growth of the shell.

"A specimen of medium size has a length of about 82 mm.; greatest breadth of cast 30 mm.; breadth of posterior end 21 mm.; greatest depth of both valves as conjoined 19 mm.; and the width at this point is 24 mm.

This was presumably a burrowing bi-valve in which the torsion, so frequently associated with the burrowing habit, has been carried to an extreme. The writer is unaware of any record for this form since the orignal discovery.

*Occurrence.*—In the Waverly beds in north western Pennsylvania, near Warren, Pa.

**Pararca transversa** Hall Plate 42, fig. 7.

**Pararca transversa** Hall, Pal. of N. Y. Vol. V, pt. I, 1885, p. 429, pl. 70 figs. 12, 13, 14.

Small, oblong, sub-elliptical; basal margin gently curving; posterior margin broadly rounded; cardinal line straight; anterior end short and regularly rounded.

Valves equally convex below, gibbous in the middle and upper portion. Beak at about the anterior third of the shell, prominent, directed forward incurved; postumbonal slope gibbous, defined and extending to the rear margin.

Surface marked by numerous fine radii which are sometimes stronger on the anterior end. Fine concentric striae are also present.

Anterior muscle often well defined, situated just below the unule.

Length usually from 22 to 25 mm. and height 15 to 16 mm. The specimen pictured measures 13 mm. in length and 9 mm. in height, and is probably an immature form.

This species is smaller than *P. sao* and has finer and more numerous ribs which are usually not arched.

*Occurrence.*—Originally described from the 'Chemung group' at Salamana, N. Y. and Warren, Pa. Our material came from the Oswayo beds at Flat Iron station near Olean Rock City, N. Y.

**Pararca equilateralis** n. sp. Plate 42, fig. 3.

Shell transversely ovate; height 28-30 mm. length 33 mm.; left valve equilateral; basal margin broadly rounded. Shell mesially most gibbous. Surface ornamentation consists of rounded radial plications which are not represented in high relief on the specimen examined. The interspaces between the individual ribs are a little wider than the width of an indivdual tria. Concentric striae intersect the radial plicae and toward the front of the shell become lamellate, thus giving the anterior surface a beruffled appearance.

This species differs from all described Pararcas in the equilateral condition of the shell, the unusually coarse plications, and the lamellate varices of growth.

*Occurrence.*—In a coarse buff colored sandstone at Glade, Pa. This is a very fossiliferous layer and may be the correlate of the Venango First Oil Sand on Stone Hill, near Stoneham, Pa.

**Pararca**, sp. undet. Plate 30A, fig. 12.

In the Oswayo formation one mile north of Olean Rock City, N. Y. in a road cut along the macadam highway several fragments of a large *Pararca* shell were found, All the known characteristics of this specimen are shown by the natural sized illustration.

## PARACYCLAS

Equivalve, subequilateral, suborbicular or subelliptical; anterior end regularly rounded or subtruncate, more produced than the anterior; beaks small and low; hinge-line short, post-cardinal slope sometimes subalate; surface marked concentrically; ligament supported internally on each side by a narrow plate, which leaves in the cast two diverging grooves directed forward from the beak; muscular impression on the post-umbonal slope; pallial line a little within the margin of the shell.

**Paracyclas erecta Hall** Plate 45, fig. 1.
Pal. of N. Y. Vol. V, I, 1885, p. 445, pl. 95, fig. 22.

*Occurrence.*—From the upper members of the 'Chemung group' at Warren, Pa. The specimens pictured were found in the yellow sandstone of the Conewango formation at Glade, Pa.

**Paracyclas ignota Hall** Plate 36, fig. 12.
Pal. of N. Y. Vol. VI, 1885, p. 444, pl. 72, fig. 34.

*Occurrence.*—The 'Chemung group' at Meadville, Pa.

**Paracyclas (?) pauper Hall** Plate 36, figs. 13-15.
Pal. of N. Y. Vol. V, I, 1885, p. 446, pl. 75, figs. 24-26; pl. 95, fig. 20.

*Occurrence.*—In the sandstone of the 'Chemung group' at Portville, N. Y.

### SCHIZODUS

Shell oval or subtrigonal; anterior side rounded, shorter than the other; posterior side tapering, truncate at the extremity, umbonal ridge extending to the postero-basal region; beaks prominent; surface smooth or with concentric striae; hinge with two smooth cardinal teeth in the right valve and three in the left; middle tooth of the left valve bifid, and fitting between two of the right valve; free margins smooth.

**Schizodus rhombeus Hall** Plate 43, figs. 17, 18, 22.
Pal. of N. Y. Vol. V, I, 1885, p. 452, pl. 75, figs. 19-23.

*Occurrence.*—In the sandstone of the Panama conglomerate in Chautauqua County, N. Y. and the middle of the 'Chemung' beds as seen near Hobbiesville, N. Y. Prosser reports this species from the top of the Bedford shales at Pennline, Pa.[47] Butts reports *S. rhombeus* from the Wolf Creek and Salamanca conglomerates[19].

**Schizodus chemungensis var. quadrangularis Hall** Plate 43, figs. 9-11, 16.
Pal. of N. Y. Vol. V, I, 1885, p. 454, pl. 75, figs. 31-34, 36.

Although this variety was first described from the Portage beds at Ithaca, N. Y. and the 'Chemung' at Factoryville, Tioga County, Pa. it has been found by Prosser at Meadville, Pa. in what he calls the Riceville formation[48]. It is reported from the Salamanca conglomerate by Butts[49] and from the 'Chemung-Salamanca conglomerate by C. Butts[49] and from the 'Chemung-Catskill' at Warren, Pa. by Lesley[50].

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[47] Prosser, Geol. Surv. of Ohio, Bul. 15, p. 39.

**Schizodus cuneus Hall** Plate 43, figs. 13, 14.

**Pal. of N. Y. Vol. V, I, 1885, p. 458, pl. 75, figs. 29, 30.**

*Occurrence.*—Waverly sandstone at Granville, Ohio.

**Schizodus oblatus Hall** Plate 43, figs. 10, 12.

**Pal. of N. Y. Vol. V, I, 1885, p. 455, pl. 75, figs. 43, 44.**

*Occurrence.*—In a sandstone of the 'Chemung group' at Cold Spring, Napoli, Cattaraugus County, N. Y.

### PROTHYRIS

Equivalve, inequilateral, extremely elongate; cardinal and basal margins subparallel; anterior end rounded or subtruncate, with a deep notch in the antero-ventral margin; posterior end rounded, lanceolate, or truncate; cardinal line straight or slightly arcuate; cardinal slope sometime subalate; umbonal slope rounded, undefined or subangular; surface concentrically lined.

**(?) Prothyris exuta Hall** Plate 39, fig. 12.

**Pal. of N. Y. Vol. V, I, 1885, p. 462, pl. 94, fig. 9.**

The most noticable features of this shell are the anterior fold and construction. Only one specimen seems to be on record from the region and this has the beak missing as is shown. It is interesting to note that James Hall suggests that the creature had this part missing in the livng state.

*Occurrence.*—From the 'upper Chemung group' at Warren, Pa.

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[48] Ibid. p. 406.

[49] Butts, N. Y. State Mus. Bul. 69, p. 994.

[50] Lesley, Pa. Geol. Surv. Dict. of Fossils, p. 937.

### PHTHONIA Hall

Equivalve, elongate-ovate, wider posteriorly; beaks obscure; surface radiated and concentrically marked; no teeth; ligament external

**Phthonia truncata Hall** **Plate 39, fig. 4.**

Pal. of N. Y. Vol. V, I, 1885, p. 476, pl. 94, fig. 4.

*Occurrence.*—In the 'Chemung group' southeast of Panama, N. Y.

**Phthonia nitida Hall** **Plate 39, figs. 10, 11.**

Pal. of N. Y. Vol. V, I, 1885, p. 477, pl. 94, figs. 5, 6.

*Occurrence.*—In a shale of the 'Chemung group' near the level of the Allegany river at Warren, Pa. Associated with *Echinocaris socialis* and other *Phyllocarida.*

### CYPRICARDINIA

Quadrilateral, inequilateral; with an oblique posterior ridge; umbones anterior elevated; concentrically grooved, sometimes cancellated; postero-cardinal margins sometimes alate. Resembles in general contour the *Cypricardia.*

**Cypricardinia consimilis Hall** **Plate 39, figs. 13, 14.**

Pal. of N. Y. Vol. V, I, 1885, p. 486, pl. 79, figs. 19, 20, 21; pl. 96, fig. 3.

*Occurrence.*—From the Waverly sandstone, Licking and Medina counties, Ohio, and at Warren, Pa.

### PALEANATINA

Transversely elongate; gaping; left valve the larger; oblique construction; hook-like process anterior to the beaks; no lateral teeth; surface concentrically lined.

**Plate 40, figs. 2, 3, 6, 13-15.**
**Paleanatina typa Hall** **Plate 41, fig. 11.**
**Plate 45, figs. 12, 13, 15, 19, 20.**

Pal. of N. Y. Vol. V, I, 1885, p. 488, pl. 79, figs. 26-28, 35-37.

*Occurrence.*—Described from a conglomerate in the 'Chemung group' at Portville, Cattaraugus County, N. Y. It has also been reported by Butts from the Wolf Creek conglomerate[51]. The species is common at Bradford, Pa. at probably the same stratigraphic position.

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[51] N. Y. State Mus. Bul. 69, p. 994

**Paleanatina solenoides Hall** Plate 39, figs. 17, 18.

Pal. of N. Y. Vol. V, I, 1885, p. 487, pl. 79, figs. 38, 39.

*Occurrence.*—Described from a conglomerate of the 'Chemung group' near Portville, Allegany County, N. Y. This species is also reported by C. Butts from the Wolf Creek and Salamanca conglomerates[51].

**Paleanatina angusta Hall** Plate 41, fig. 10.
Plate 45, fig. 11, 14, 16, 18.

Pal. of N. Y. Vol. V, I, 1885, p. 490, pl. 79, figs. 29-34.

This is a smaller and more elongate species than the preceeding two. (Figure 14, plate may not belong to this species as James Hall points out in the original description.)

*Occurrence.*—In a conglomerate of the 'Chemung group' near Portville, N. Y.

**Paleanatina sinuata Hall** Plate 39, fig. 19.

Pal. of N. Y. Vol. V, I, 1885, p. 491, pl. 96, fig. 4.

The well developed 'wing' which is separated from the umbonal ridge by a rather deep sulcus is characteristic of this species.

*Occurrence.*—The 'Chemung group' at Warren, Pa.

### ELYMELLA

Equivalve, inequilateral, ovate, elliptical; anterior end short, rounded; posterior end narrow, rounded; beaks closely incurved; umbo prominent in the upper part, not defined below; surface concentrically lined.

**Elymella (?) chadwicki n. sp.** Plate 42, fig. 2.

Shell large, nuculoid, moderately convex. Umbo moderately elevated. Length 41 mm.; height 29 mm. Beak in the anterior fourth of the shell; surface marked by concentric striae of varying size; these become fasciculate on the anterior portion of the shell. Other specific characters are shown by the illustration.

Due to the absence of musculation impressions and dentition the exact generic reference of this species is impossible at pres ent. In general appearance this shell most resembles the illustrations of *Elymella patulata* Hall.

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[51] N. Y. State Mus. Bul. 69, p. 994

This species is named for Prof. G. H. Chadwick whose work on the stratigraphy of western New York and surrounding regions is a real contribution to Geology.

*Occurrence.*—In the very fossiliferous beds, which have been referred to the Venango First Oil Sand by Verwiebe on Stone Hill southeast of Stoneham, Pa. The most common of the associated species are *Spirifer disjunctus* and *Syrin . angulata*

### SANGUINOLITES

Subequivalve, oblong, elongated, margins sub-parallel or little arched upward; sides compressed or diagonally gibbous from the beak backward; beaks small, anterior; hinge nearly as long as the shell, margin inflected to form a long posterior lunette; surface wrinkled; large, oval adductor impression in front of the beak surmounted by a small retractor; posterior adductor large; cartilage external; pallial line entire; shell thin.

**Sanguinolites (?) undulatus Hall** · Plate 43, figs. 15, 19.

Pal. of N. Y. Vol. V, I, 1885, p. 508, pl. 64, figs. 1, 2.

*Occurrence.*—Sandy shales of the 'Chemung group' near Great Valley and East Randolph, Cattaraugus County, N. Y.

**Sanguinolites (?) subtruncatus Hall** Plate 43, figs. 20, 21.

Pal. of N. Y. Vol. V, I, 1885, p. 508, pl. 64, figs. 3, 4.

*Occurrence.*—In the arenaceous shales of the 'Chemung group at Conewango, Cattaraugus County, and at Cherry Creek, Chautauqua County, N. Y.

## GASTROPODA

### BELLEROPHON

**Bellerophon mæra Hall** Plate 47, figs. 3-8.

Pal. of N. Y. 1879, p. 119, pl. 25, figs. 4-9, 26; pl. 26, figs. 19-24.

*Occurrence.*—In the shaly beds of the 'Chemung group' at Phillipsburg, Allegany County, and in the sandstone below the conglomerate near Mansfield, Tioga County, Pa. etc. Specimens referred to this species were found in the sandstone immediate ly above the Sub Olean conglomerate just east of Stoneham, Pa.

## EUOMPHALUS

**Euomphalus (Straparollus) hecale** Hall Plate 47, figs. 9-13.
Plate 48, figs. 1, 2, 13.

Pal. of N. Y. Vol. V, II, 1879, p. 59, pl. 16, figs. 10-14.

*Occurrence.*—In the 'Chemung group' at Rockville, Allegany County, N. Y., near Ithaca (in the Portage) at Elmira and at Meadville, Pa. This species is very common in the Panama conglomerate at Checkered School House near Panama, N. Y. also in the Salamanca conglomerate north of Salamanca, N. Y.

**Euomphalus** sp. Plate 1.

Internal molds and external impressions of an euomphaloid form is very common in the sandstone of the Venango First Oil Sand group on Stone Hill south east of Warren, Pa.

## PLATYCERAS

Members of this genus are extremely common in the fossiliferous sandstone just above the Sub-Olean conglomerate on Stone Hill, and at Stoneham, Pa. These beds are referred by Verwiebe to the Venango First Oil Sand group. This is quite possibly the horizon to which Simpson had reference when he says 'Chemung group' in the descriptions of his various species from near Warren, Pa.

**Platyceras dorsale** Simp. Plate 46, figs. 8, 9.

Tr. Am. Phil. Soc. ns. 16, 1889, p. 454, fig. 24, nos. 1, 2.

*Occurrence.*—In the 'Chemung group' three miles north west of Warren, Pa. Specimens which have been referred to this species were also found in the sandstones of Lower Carboniferous age at Glade, Pa.

**Platyceras breve** Simp. Plate 46, figs. 10-13.

Tr. Am. Phil. Soc. ns. -6, 1889, p. 454, fig. 23, no. 4.

*Occurrence.*—In the 'Chemung group' near Warren, Pa.

**Platyceras striatum** Simp. Plate 46, figs. 14, 15.

Tr. Am. Phil. Soc. ns. 16, 1889, p. 457, fig. 27, nos, 1, 2.

*Occurrence.*—In the 'Chemung group' four miles north west of Warren, Pa.

**Platyceras inæquale** Simp. Plate 46, figs. 16-18.

Tr. Am. Phil. Soc. ns. 16, 1889, p. 456, fig. 25, nos. 1, 2, 3.

*Occurrence.*—In the 'Chemung group' four miles north west of Warren, Pa.

**Platyceras mitelliforme** Simp. Plate 46, figs. 19, 20.

Tr. Am. Phil. Soc. ns. 16, 1889, p. 456, fig. 26.

It would seem that this species and *P. inæquale* are synonymous.

*Occurrence.*—From the 'Chemung group' near Warren, Pa. Specimens very near to both this species and *P. inæqual* have been found in the Venango First Oil sand as exposed on Stone Hill near Stoneham, Pa.

**Platyceras varians** Simp. Plate 46, fig. 21.

Tr. Am. Phil. Soc. ns. 16, 1889, p. 458, figs. 28.

*Occurrence.*—In the 'Chemung group' four miles north west of Warren, Pa.

**Platyceras reudemanni,** n. sp. Plate 48, figs. 4, 5.

This species is known only from a single imperfect mold but is so different from all the associated Platyceras that it seems to warrant description.

The fragment is 31 mm. high and 16 mm. in width at the base (ventral-dorsal diameter).

The illustration is natural size and shows nearly all of the characteristic features of the shell.

The large size, slightly coiled condition, carinated dorsum, and sinuous peristome together with the surface varices of growth, best seen near the peristome, characterize the species.

This form seems to be closest related to the uncoiled forms described by Simpson from western Penna. such as *P. dorsale,* which is not coiled as much and is more conical and shorter though it does have the definite dorsal carina and surface striations near the peristome.

*Occurrence.*—In a very fossiliferous sandy limestone which weathers to a dark chocolate brown stone containing an abundance of molds and casts, one and a half miles east of Glade, Pa. This is probably the Oswayo horizon.

### PLEUROTOMARIA

**Pleurotomaria** sp. Plate 48, figs. 3, 10, 11, 12, 14, 15.

A small, profusely ornamented *Pleurotomaria* is one of the rather common fossils found in the brownish yellow sandstone belonging to the Venango First Oil Sand group (Cuyahoga) at Stone Hill, south east of Stoneham, Pa. The specimens usually are from 4 to 5 mm. in height and five or six whorls are usually visible. It is quite probably a form closely related to species described from Illinois, or Ohio Mississippi beds. The specific determination is uncertain at this time.

Associated with this genus are *Syringothyris angulata, Spirifer disjunctus, Chonetes, Euomphalus, Camerotœchia contaracta* and *sappho, Retzial* sp., *Elymella* (?), *Platyceras, Bellerophon, Reticularia praematura,* etc.

**Anomia (?), Archinacella (?) incerta** n. sp. Plate 41, fig. 13.

(Description based on a single known specimen.)

Shell ovate in outline; length 25 mms. width 21 mms.; regularly convex, slightly more gibbous anteriorly. Umbone orignates at the front margin; sides slightly flaring.

Surface marked by concentric growth lines which are imbricate on the anterior lateral margins. A poorly developed umbonal carina is present, though this may be caused by pressure. (The similarity of this carina to that present in many East Coast *Anomia* is remarkable). The microscopic ornamentation consists of two series of radiating striae. The coarser of these is barely discernible microscopically; the other and much finer series is visible only upon considerable magnification, and occupies the spaces between the first series. The striae are best developed umbonally.

The shell structure is punctate and granular and has a chitonous appearance much resembling the shells of *Lingula* or *Orbiculoidea* and on this evidence seems more likely referable to the Brachiopoda.

*Note.*—The internal characters of this shell are unknown, except for two or three indistinct shallow, ovoid depressions on the umbonal area which might represent the collapse of the shell over internal muscular scars. The external appearance of this shell is remarkably like that of *Anamia simplex Anomia ephippium*) of the East Coast, however, the shell structure seems to preclude a reference to the Pelecypoda. It also is very much like the Gastropod *Archinacella* of Ulrich[52] in general external appearance, but *Archinacella* has no striæ and seems to have never been found so high in the geologic scale. Briefly, this is among the *incertæ sedes.*

*Occurrence.*—At the base of the Conewango at Stone Hill near Stoneham, Pa. The matrix is a fine gray shale and bears an abundant fauna.

## CEPHALOPODA

### ORTHOCERAS

**Orthoceras leander** Hall Plate 49, fig. 8

Pal. of N. Y. Vol. V, II, 1879, p. 309, pl. 90, figs. 6-8.

*Occurrence.*—From the sandstone of the 'Upper Chemung' at Warren, Pa.

**Orthoceras bipartitum** Hall Plate 50, figs. 9, 10.

Pal. of N. Y. Vol. V, II, 1879, p. 313, pl. 113, figs. 20, 21.

*Occurrence.*—In the sandstones of the 'Upper Chemung' group at Warren, Pa.

**Orthoceras warrenense** Miller Plate 50, fig. 7.

**Orthoceras cochleatum** Hall, Pal. of N. Y. V, II, 1879, p. 308, pl. 113, fig. 19.

**Orthoceras warrenense** Miller, N. A. Geol. and Pal. 1889, p. 452.

*Occurrence.*—In the sandstones of the 'Chemung group' at Warren, Pa.

**Orthoceras consortale** Beecher Plate 50, figs. 3-5.

Pal. of N. Y. Vol. VII, 1888, p. 29, pl. 118, figs. 3-5.

*Occurrence.*—In the sandstones of the 'Chemung group' at Panama, N. Y.

**Orthoceras** sp. Plate 49, figs. 1, 2, 7.

In the highest conglomerate on Robins Hill about one mile east of the Cattaraugus-Chautauqua County line a very large Orthoceras was found. The specific affinities are not yet determined.

In the sandstone from the Venango First Oil Sand horizon at Stoneham and Stone Hill and Cobham, Pa. fragments of Orthoceras are not uncommon. In this place they are usually small.

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[52] Ulrich, E. O. Geol. Surv. Minn, III, pt. II, 1897.

### CYRTOCERAS

**Cyrtoceras (?) hector** Hall Plate 50, figs. 4, 5.

Pal. of N. Y. Vol, V. II, 1879, p. 364, pl. 90, figs. 11-16.

*Occurrence.*—In a sandstone of the 'Upper Chemung' at Olean. N. Y. and also at Warren, Pa.

### GOMPHOCERAS

**Gomphoceras nasutum** Hall Plate 49, fig. 6.

Pal. of N. Y. Vol. VII, 1888, p. 34, pl. 120, figs. 5-7.

*Occurrence.*—In the arenaceous shales of the 'Chemung group' at Belmont and Belvidere, Allegany County, N. Y.

**Gomphoceras tumidum** Hall Plate 50, fig. 2.

Pal. of N. Y. Vol. V, II, 1879, p. 351, pl. 93, fig. 6; pl. 95, figs. 2-5, 7.

*Occurrence.*—In the shales of the 'Chemung group' near Ithaca, N. Y. and in the calcareous beds of the 'Upper Chemung' group near New Albion, Cattaraugus County, N. Y.

**Gomphoceras** sp. Plate 49, fig. 3.

In the light brown quartzitic sandstone 100 feet above the road at Glade, Pa. the specimen illustrated was found. The illustration is natural size. The specific reference of this specimen is not known. With it were many large *Ptychopteria* and *Leptodesma*, and many *Spirifer disjunctus*.

### GYROCERAS

**Gyroceras stebos** Hall Plate 47, fig. 1.

Pal. of N. Y. Vol. VII, 1888, p. 36, pl. 125, fig. 7.

This is one of the finest fossils from the Warren area, but is evidently very rare. It seems to have never been recorded since the original description was written.

*Occurrence.*—In the sandstone of the Waverly group at Warren, Pa.

## DICTYOSPONGES

These are usually large, funnel shaped, cylindrical or prismatic sponges whose walls are frequently diversified by ridges and prominences. The skeletal framework is very regular and is composed of larger and smaller quadrate meshes situated one within the other. The framework is formed by bundles of slender spicules.—From Zittel.

### HYDNOCERAS

**Hydnoceras nodosum** Hall Plate 51, fig. 2.

15th Rep. N. Y. State Geol. 1898, p. 848, pl. 2, fig. 2.

*Occurrence.*—In the shaly sandstones in the 'Chemung group' in Cattaraugus County, N. Y.

### PRISMODICTYA

**Prismodictya prismatica** (Hall) Plate 53, fig. 6.

15th Rep. N. Y. State Geol. 1898, p. 823, pl. 17, fig. 1; pl. 21, figs. 1-6; pl. 42, fig. 6.

*Occurrence.*—In the upper beds of the 'Chemung group'; in great numbers in the light gray sandstone at Concord, Erie County, Pa.; also at Wellsville and Olean, N. Y., and at Warren, Pa.

**Prismodictya allegania** Hall Plate 53, fig. 5.

15th Rep. N. Y. State Geol. 1898, p. 824, pl. 20, fig. 4.

*Occurrence.*—In the upper beds of the 'Chemung group' at Scio and Almond, Allegany County and at Ischua and Olean, Cattaraugus County, N. Y.

**Prismodictya choanea** Hall Plate 53, fig. 3.

15th Rep N. Y. State Geol. 1898, p. 825, pl. 19, figs. 1-3; pl. 27, fig. 5; pl 35, fig. 6.

*Occurrence.*—In the upper beds of the 'Chemung group' at Ischua and Olean, N. Y.

**Prismodictya conradi** Hall Plate 52, fig. 4.

15th Rep. N. Y. State Geol. 1898, p. 831, pl. 18, fig. 4; pl. 19, figs. 5, 6.

*Occurrence.*—In the upper beds of the 'Chemung group' at Randolph, N. Y.

### CLATHROSPONGIA

**Clathrospongia abacus** Hall Plate 52, figs. 1-3.
16th Rep. N. Y. State Geol. 1899, p. 345, pl. 49, figs. 5, 6.

*Occurrence.*—In the sandstone of the Waverly group, associated with *Ectenodictya implexa* and an undetermined *Spirifer* or *Syringothyris,* at Warren, Pa.

### THYSANODICTYA

**Thysanodictya expansa** Hall Plate 51, fig. 1.
16th Rep. N. Y. State Geol. 1899, p.346 , pl. 53, fig. 3.

*Occurrence.*—In the sandstone of the Waverly group at Warren, Pa.

**Thysanodictya randalli** (Hall) Plate 51, fig. 4.
15th Rep. N. Y. State Geol. 1898, p. 869, pl. 24, fig. 12.

*Occurrence.*—In the 'Chemung group' associated with *Spirifer disjunctus* at Warren, Pa.

### CALATHOSPONGIA

**Calathospongia carlii** Hall Plate 52, fig. 5.
16th Rep. N. Y. State Geol. 1899, p. 350, pl. 52, figs. 4, 7, and text fig. 21.

*Occurrence.*—"In the sandstone of the Waverly group found loose on the flats of Oil Creek, Pa. near the mouth of Pine Creek. The stream here cuts down about 15 feet below the 'Berea grit' " letter from Mr. Carll to James Hall. This species is also found near Pleasant Valley, Venango County, Pa. This species also occurs in the same rocks at Warren, Pa.

**Calathospongia redfieldi** (Hall) Plate 53, figs. 1, 2.
16th Rep. N. Y. State Geol. 1899, p. 347, pl. 48, figs. 1, 2; pl. 49, figs. 1-4.

*Occurrence.*—"This specimen upon which the original description was based was collected near Harrisville, Medina County, Ohio, in a yellow sandstone of the Waverly group. It has also been found in the Cuyahoga shale of the Waverly group at Akron, Ohio, and at Richfield, Ohio, and also in the Waverly sandstone on Nelson's farm near Pleasant Valley, Venango County, Pa.

### TYLODICTYA

**Tylodicta warrenensis** Hall Plate 53, fig. 4.

16th Rep. N. Y. State Geol. 1899, p. 343, figs. 18, 19, 20.

*Occurrence.*—In the Waverly sandstone at Warren, Pa.

**Tylodicta (?) tenuis** (Hall) Plate 51, fig. 3.
16th Rep. N. Y. State Geol. 1899, p. 344, pl. 53, figs. 4, 5.

*Occurrence.*—In the Waverly sandstone at Warren, Pa.

### ECTENODICTYA

**Ectenodictya implexa** Hall Plate 51, fig. 5.

16th Rep. N. Y. State Geol. 1899, p. 356, pl. 54, figs. 3, 4.

*Occurrence.*—In the Waverly group at Warren, Pa. where it is associated with *Syringothyris angulata;* found also in the same formation at Oil City, Pa.

## ARTHROPODS

### TROPIDOCARIS

**Tropidocaris bicarinatus** Beecher Plate 54, figs. 1, 3, 4, 6, 7, 9, 10.

2nd. Geol. Surv. of Pa. Vol. PPP. 1889, p. 16.
Geol. Journ. Vol. 58, 1902, p. 445, pl. 19, figs. 1-5.

*Occurrence.*—In the shales at the base of the 'Chemung group' as exposed at Warren, Pa.

**Tropidocaris interrupta** Beecher Plate 59, fig. 3.

2nd Geol. Surv. of Pa. Vol. PPP, 1884, p. 18.
Pal. of N. Y. Vol. VII, p. 185, pl. 31, fig. 15.

*Occurrence.*—In soft shales belonging to the Chemung as expressed at an elevation of 300 feet above the Allegany river at Warren, Pa.

**Tropidocaris alternata** Beecher Plate 59, figs. 4, 5.

2nd. Geol. Surv. of Pa. Col. PPP, 1884, p. 19.
Geol. Journ. Vol. 58, 1902, p. 447, pl. 19, fig. 6.

*Occurrence.*—In the sandstones of the Waverly group at Warren, Pa. associated with numerous species of Brachiopods, Pelecypods, and Gastropods.

### ECHINOCARIS

**Echinocaris socialis** Beecher Plate 55, figs. 4, 6-8.

2nd. Geol. Surv. of Pa. Vol. PPP, 1884, p. 10.
Geol. Journ. Vol. 58, 1902, p. 441, pl. 17; pl. 18, figs. 1-7.

*Occurrence.*—In the shales at the base of the 'Chemung group' as exposed at Warren, Pa.

**Echinocaris clarkii** Beecher Plate 54, fig. 5.

Geol. Journ. Vol. 58, 1902, p. 443, pl. 18, fig. 9.

*Occurrence.*—In the shales of the Waverly group at Warren, Pa.

**Echinocaris randalli** Beecher Plate 55, fig. 5.
Geol. Journ. Vol. 58, 1902, p. 443, pl. 18, fig. 8.

*Occurrence.*—In the sandstones and shales of the Waverly group at Warren, Pa.

### ELYMOCARIS

**Elymocaris siliqua** Beecher Plate 54, figs. 2, 3.

2nd. Geol. Surv. of Pa. Vol. PPP, 1884, p. 13.
Geol. Journ. Vol. 58, 1902, p. 447, pl. 19, figs. 7, 8.

*Occurrence.*—In the lower arenaceous and micaceous shales of the 'Chemung group' as exposed at Warren, Pa.

### STYLONURUS

**Stylonurus beecheri** (Hall) Plate 55, fig. 3.

Mem. N. Y. State. Mus. No. 14, 1902, p. 310.
Pal. of N. Y. Vol. VII, 1888, pl. 27, fig. 5.

*Occurrence.*—In the sandstones of the 'Chemung group' at Warren, Pa.

### PRESTWICHIA

**Prestwichia randalli** Beecher Plate 59, fig. 6.

Am. Geol. Vol. 29, 1902, p. 143, fig. 1.

*Occurrence.*—In the sandstone of the 'Upper Chemung' group near Ackley Station, Warren County, Pa.

### EURYPTERUS

**Eurypterus pennsylvanicus** C. E. Hall Plate 59, fig. 7.

2nd. Geol. Surv. of Pa. Vol. PPP, 1884, p. 31.

*Occurrence.*—In an arenaceous shale at the Rooker farm, Pithole, Venango County, Pa.

### DALMANITES

**Dalmanites (?)** sp. , Plate 59, figs. 10, 11.

In the Oswayo beds at Flat Iron Station near Olean, Rock City, N. Y. the impression of the pygidium of a trilobite was found. Due to the coarseness of the matrix little could be determined from the specimen aside from the fact that the pygidium was fringed as it is in some *Dalmanites*.

### PROTOLIMULUS

**Protolimulus eriensis** (Wms.) Plate 55, figs. 1, 2.

**Prestwichia eriensis** Williams, Am. Jour. of Sci. Vol. 30, No. 175, u. 45, 1885.
**Protolimulus eriensis** Packard, Mem. Nat. Acad. Sci. p. 150, figs. 11-13.
**Protolimulus eriensis,** Hall, Pal. N. Y. VII, p. 153, pl. 27, figs. 1, 2, 1888.

The original specimen of this species was discovered by C. S. Prosser in LeBouef, Erie County, Pennsylvania. The horizon according to Professor Williams' original description was: "The Chemung group, upper Devonian; the third oil sand, of I. C. White, 2nd Pa. Survey."

The dimensions of the original specimen were:

| | | |
|---|---|---|
| Total length | 10 | cm. |
| Greatest width | 5.7 | cm. |
| Length of telson (about) | 4. | cm. |
| Length of buckler (about) | 2. | cm. |
| Greatest thickness of telson | 7 | cm. |

Our specimen while undobutedly a Protolimulus is too fragmentary to make specific identification certain. The eight longitudinal ridges are the most outstanding character; these together with the arched caudal margin of the gnathopods were the primary characters for reference. The cephalic shield together with its genal spines has been broken off and the region of the gnathopods much eroded. There seems to be a trace of the anchylosed primary segments of the thorax and a portion of the flat median depression between the anchylosed segments. The marginal spines of the telson and the buckler have been eroded. The length of the fragment is 3.5 mm. and the width 7. mm.

*Occurrence.*—The specimen was found in the quarry of the ceromic plant at Lewis Run, Pa., southwest of Bradford, Pa. The matrix is of a greenish brown color and contains fish remains in abundance.

# VERTEBRATES

## FISHES

### CTENACANTHUS

> "Les **Ctenacanthus** sont d'immense rayons tres-comprimés, à base large, mais a cavite plus petite que celle des **Oracanthus**. La partie de ses rayons cachée dans les chairs parait avoir été considerable. Au bord posterior se voient quelques petites épines. La surface est ornée de striés longitudinales, plus raprochees que celles de **Hybodes**, pectinées, c'est-a-dire crenelées transversalement et saillaintes en forme de dents qui alternent d'une serie a l' autre, mais qui semblent continuer a cause de leur obliquité."—Agassiz.

Dorsal fin spines; robust, often attaining a large size, laterally compressed; sides of exserted portion ornamented with longitudinal ridges, usually crenulated or denticulated, rarely smooth; posterior face flat or concave, with a series of small denticles upon each margin.

Dr. Newberry suggested that *Ctenacanthus* and *Orodus* might be synonymous, having found them together in the Waverly shales of Ohio. The British Museum catalog states that it is noteworthy that the largest spines of *Ctenacanthus* occur in the Bristol Carboniferous Limestone where are also found the largest teeth of *Orodus*.

The following list of *Ctenacanthus* have been described from North American Devonian and Carboniferous formations. It may be helpful in attempting specific identification of any forms found in the Bradford and Warren areas.

**C. angulatus**, Newb. and Worth.
  Pal. III. V, II, 1866, p. 118. Chester Limestone, Ill.
**C. angustus** Newb.
  Mo. U. S. G. S. No. 16, 1889, p. 181; Berea grit, Berea, Ohio.
**C. burlingtonensis** St. John and Worth.
  Pal. III. V, VI, 1875; Upper Burlington limestone, Ill. and Ind.
**C. buttlersi** St. John and Worth.
  Pal. III. Op. Cit. V, VII; Lower coal measures of Ill.
**C. cannaliratus** St. John and Worth.
  Pal. Ill. Op. Cit. Chester Limestone, Ill.
**C. chemungensis** Claypole.
  Mem. N. Y. State Mus. No. 10, 1907, p. 77. Chemung group of N. Y.
**C. clarki** Newb.
  Mon. U. S. G. S. No. 16, 1889, p. 168; Cleveland shales, Berea, Ohio.

- **C. compressus** Newb.
  - Mon. U. S. G. S. No. 16, 1889, p. 168; Cleveland and shale, Ohio.
- **C. coxianus** St. John and Worth.
  - Pal. Ill. V, VII, p. 233; Keokuk Limestone, Ill.
- **C. cylindricus**, Newb.
  - Mon. U. S. G. S. No. 16, 1889, p. 202; Keokuk limestone and shale, Kty.
- **C. deflexus** St. John and Worth.
  - Pal. Ill. V, VII, St. Louis limestone, Ill.
- **C. elegans** Toumey
  - Geol. of Alabama, 1858, p. 38; Lower carboniferous.
- **C. excavatus** St. John and Worth.
  - Pal. Ill. V, VI, p. 428; Keokuk limestone of Ia. and Mo.
- **C. formosus** Newb.
  - Geol. Surv. of Ohio, V, I, pt. II; Waverly group, Ohio and Kty.
- **C. furcicarinatus** Newb.
  - Geol. Surv. of Ohio, V, I, pt. II, Waverly group, Ohio.
- **C. gemmatus** St. John and Worth.
  - Pal. Ohio, V, VI, p. 429; St. Louis limestone, Ill.
- **C. graciilimus** Newb and Worth.
  - Pal. of Ohio, V, VI; St. Louis limestone.
- **C. gradacostata** St. John and Worth.
  - Pal. Ohio, V, VI, p. 425; Upper Burlington limestone, Ia. and Ill.
- **C. harrisoni** St. John and Worth.
  - Pal. of Ohio, V, VII, p. 236; St. Louis limestone, Ill.
- **C. keokuk** St. John and Worth.
  - Pol: of Ohio, V, VI, p. 427; Keokuk limestone of Ill. Ia. and Mo.
- **C. littoni** Newb.
  - Mon. U. S. G. S. No. 16, 1889, p. 201; St. Louis limestone, Mo.
- **C. marshi** Newb.
  - Geol. Surv. of Ohio, V, I, pt. II, p. 326; Coal Measures, Ohio.
- **C. mayi** Newb. and Worth.
  - Pal. of Ill. V, IV, 1870, p. 370; Lower Cab. limestone, Ia.
- **C. parvulus** Newb.
  - Pal. of Ohio, vol. II.
- **C. pellensis** St. John and Worth.
  - Pal. Ill. V, VII, p. 237; St. Louis limestone, Ia.
- **C. pugiunculus** St. John and Worth.
  - Pal. Ill. V, VI, p. 430; St. Louis limestone, Mo.
- **C. randalli** Newb.
  - Mon. U. S. G. S. No. 16, p. 105; Olean conglomerate, Warren, Pa.
- **C. sculptus** St. John and Worth.
  - Pal. of Ill. V, VI, p. 421; Kinderhook limestone, Ia.
- **C. similis**, St. John and Worth.
  - Pal. Ill. V, VI, p. 431; Chester limestone, Ill.
- **C. spectosus** St. John and Worth.
  - Pal. Ill. V, VI, p. 424; Kinderhook limestone, Ia.
- **C. spectabilis** St. John and Worth.
  - Pal. Ill. V, VI, p. 420; Kinderhook limestone, Ia.
- **C. triangularis** Newb.
  - Geol. Surv. V, I, 1873, p. 329; Waverly group, Warren, Pa.
- **C. varians** St. John and Worth.
  - Pal. Ill. V, VI, p. 422; Kinderhook limestone, Ia.
- **C. vetustus** Newb.

Geol. Surv. Ohio, V, I, pt. I, p. 326; Huron shales of Ohio.
**C. wrighti** Newb.
Mon. U. S. G. S. No. 16, 1889. p. 66; Hamilton group, N. Y.
**Ctenacanthus randalli** Newb.
Mon. U. S. G. S. No. 16, 1889, p. 105, not pictured.

Dorsal spine, 12 inches long, 1½ inches wide at base of ornamentation; backward curving, laterally compressed, basal portion conical, smooth or finely striated longitudinally. Line of demarcation between the ornamented surface and the base strongly marked. Ornamented surface near the base formed by about 40 fine parallel sub-equal, finely crowded ribs on each side of the median line. These bear small rounded closely approximated tubercles.

*Occurrence.*—Originally found in the Olean conglomerate (Pocono), two miles northeast of Warren, Pa. Several other specimens have been found in this vicinity but never have been illustrated.

**Ctenacanthus chemungensis** Claypole Plate 56, fig. 9.

Mem. N. Y. State Mus. No. 10, 1907, p. 77, pl. 7, fig .3.

The spines are small, narrow and finely ornamented. The length is less than 10 mm. Costæ thread-like. Surface of impression punctate.

*Occurrence.*—Collected by Beecher and others from the Chemung ebds in Warren County, Pa. Other specimens have been found in the Chemung beds between Friendship and Nile, N. Y.

**Ctenacanthus triangularis** Newb. Plate 56, figs. 1, 2.

Pal. of Ohio, I, 1873, p. 329, pl. 36, figs. 1, 1a.

The illustration shows the characters of this species sufficiently well. They are usually 4 to 6 inches long.

*Occurrence.*—More than a dozen specimens were found on a slab of sandstone detached from a cliff below the conglomerate on the bank of Oil Creek, Pa. With these specimens were also found several teeth too poorly preserved to identify. One of the teeth had, however, somewhat the form of those of *Acrodes* and might be considered a tooth of *Orodus* but the others are more like those of *Psammodus*. The horizon is Waverly.

**Ctenacanthus harrisi**, n. sp. Plate 57, fig. 1.

Dorsal spine represented by a fragment 13 cm. long; probably at least 18 cm. long in life. The width along the line of insertion is about 6 cm.; thickness at posterior point of insertion 27 mm. Spine curves slightly posteriorly, laterally flattened, posteriorly invaginated; the depth of the invagination at the point of insertion of the spine being a little over one-half the thickness of the spine.

The line of separation between the ornamented surface and the inserted portion is very oblique and slightly convex. The inserted portion of the spine is longitudinally striate, the striæ becoming regularly imbricated.

The ornamentation of the external surface consists of about 40 longitudinal costæ (about 19 or 20 on each side of the median-line) which are much elevated and are separated from each other by sulci which are slightly narrower than the width of one ridge. The ridges in the front part of the spine are the widest. The 8 posterior lateral costæ bifucate just before reaching the line of insertion.

Each elevated ridge bears many well developed square or slightly transverse tubercles. There are from 12 to 14 of these to a cm. They are spaced from each other about the width of one tubercle.

The ribs are less numerous than in *C. randalli* and the tubercles are differently spaced and shaped. The ribs are closer together than in *C. tenuistriatus* which *C. harrisi* approaches in the number of ribbs and shape of tubercles. *C. harrisi* differs from *C furc'carinatus* in the character of the tuberculation and the number of bifurcating costæ.

This spine is named in honor of Prof. G. D. Harris of Cornell University who discovered the specimen.

*Occurrence.*—One mile east of Mt. Jewett, Pa., on the Roosevelt highway, at a rock cut through which the road passes. The beds are about 50 feet below the white quartzitic conglomerate which outcrops over a large area on the hill top at Mt. Jewett. The matrix is a brown sandy material which contains an abundance of flattened clay pellets and frequently coarse pebbles.

Associated with the fish remains was an abundance of plant remains and a fauna among which were: *Syringothyris angulata, Spirifer disjunctus, Leptodesma mentor,* var. *maxima, Camarotoechia* sp. etc. The horizon is quite probably Mississippian.

### HOLONEMA

**Holonema rugosa** (Claypole) Plate 56, fig. 3.

Mon. U. S. G. S. No. 16, 1889, p. 93, pl. 17, figs. 1-4.

The surface ornamentation of a Placaderm which consists of raised enamel lines which are often simple and parallel but more frequently broken and tortuous.

*Occurrence.*—In the Chemung rocks at Franklin, Delaware County, N. Y., at LeRoy, Bradford County, Pa., and in the Catskill rocks of north-central Pa. The illustrated specimen came from below the second conglomerate at Bradford, Pa.

### DINICHTHYS

**Dinichthys tuberculatus** Newb. Plate 56, fig. 5.

Mon. U. S. G. S. No. 16, 1889, p. 98, pl. 37, fig. 3.

The plates of this species are very thick, often attaining one-half to one-quarter inch in thickness.

*Occurrence.*—In the fish beds of the Chemung conglomerate at Warren, Pa. This same species occurs also according to Dr. Newberry, in the *Psamile de Condroz,* the correlate of our Chemung, near Liege, Belgium.

### HOLOPTYCHUS

**Holoptychus (Sauripteris?) taylori** (Hall) Plate 57, fig. 2.

Geol. of the 4th Dist. of N. Y. State, 1843, p. 282, Ill.

*Occurrence.*—Originally described from the Catskill group at Blossburg, Pa. The illustrated specimens came from the Chemung beds at Bradford, Pa. and is referred with hesitation to this species.

**Holoptychus americanus** Leidy Plate 57, fig. 5.

Mon. U. S. G. S. No. 16, 1889, p. 113, pl. 19, figs. 12, 13.

*Occurrence.*—The Catskill rocks of N. Y. and Pa.; not common. Reported from between the Wolf Creek and Salamanca conglomerates by Butts.*

*Bul. N. Y. State Mus. No. 69, p. 994.

**Holoptychus (?) pustulosus** Newb. Plate 56, fig. 10.

Mon. U. S. G. S. No. 16, 1889, p. 100, pl. 20, figs. 11, 11a.

Thick bony scales which are round, ovoid or elliptical; usually not over 2 by 1½ inches in size; central portion coarsely tuberculate. Exact relationship not known.

*Occurrence.*—Found in the 'Chemung group' at Warren, Pa.

### GANORHYNCHUS

**Ganorhynchus beecheri** Newb. Plate 56, fig. 6.

Mon. U. S. G. S. No. 16, 1889, p. 95, pl. 19, fig. 2.

*Occurrence.*—The Chemung and Catskill beds at Warren, Pa.

### DIPTERUS

**Dipterus (Ctenodus) flabelliformis** Newb. Plate 58, figs. 10, 16.

Mon. U. S. G. S. No. 16, 1889, p. 90, pl. 27, figs. 21, 21a.

*Occurrence.*—Found in the 'Chemung group' at Warren, Pa.

**Dipterus (Ctenodus) nelsoni** Newb. Plate 58, figs. 1, 11.

Mon. U. S. G. S. No. 16, 1889, p. 89, pl. 27, figs. 19, 20.

The teeth of this species are distinguishable from the teeth of other *Ctenodus* by the strong sub-arcuate ridges, the edges of which are highly polished. In some forms the teeth are without any ridges; and in younger forms the ridges are often with undulations and almost tuberculate.

*Occurrence.*—In the 'Chemung group' at Warren, Pa.

**Dipterus (Ctenodus) levis** Newb. Plate 58, figs. 15.

Mon. U. S. G. S. No. 16, 1889, p. 90, pl. 27, figs. 22.

Four or five short ridges which are usually smooth and polished. The central portion is plain.

*Occurrence.*—In the 'Chemung group' at Warren, Pa.

**Dipterus (Ctenodus) quadratus** Newb. Plate 13, figs. 13, 14.

Mon. U. S. G. S. No. 16, 1889, pl. 27, figs. 24, 25.

*Occurrence.*—In the 'Chemung group' at Warren, Pa .

**Dipterus (Ctenodus) minutus** Newb. Plate 58, fig. 15.

Mon. U. S. G. S. No. 16, 1889, p. 91, pl. 27, figs. 26.

*Occurrence.*—In the 'Chemung conglomerate' at Warren, Pa.

### RHADINICHTHYS

**Rhadinichthys (?) sp.** Eastman Plate57,figs.3,6.

Mem. N. Y. State Mus. No. 10, 1907, p. 172, pl. 4, fig. 11; pl. 9, fig. 4.

*Occurrence.*—In the 'Chemung group' at Warren, Pa.

### BOTHRIOLEPIS

**Bothriolepis minor** Newb. Plate 57, fig. 4.

Mon. U. S. G. S. No. 16, 1889, p. 112, pl. 20, fig. 7.

*Occurrence.*—The 'Chemung group' at LeRoy, Bradford County, Pa. and reported by Mr. C. Butts (N. Y. State Mus. Bul. 69, p. 994.) from between the Wolf Creek and Salamanca conglomerates.

### HOMACANTHUS

**Homacanthus acinaciformis** East. Plate 58, fig. 3.

Me. N. Y. State Mus. No. 10, 1907, p. 75, pl. 1, fig. 16.

The small size, slenderness, gentle curvature and lateral ridges, together with the aciculate posterior denticles characterize this species.

*Occurrence.*—In the 'Chemung group' at Warren, Pa.

### APEDODUS

**Apedodus priscus** Leidy Plate 58, figs. 4, 5.

Mon. N. Y. State Mus. No. 10, 1907, p. 166, pl. 1, figs. 1, 2.

*Occurrence.*—In the 'Chemung beds' at Warren, Pa.

### GYRACANTHUS

**Gyracanthus sherwoodi** Newb. Plate 58, figs. 7, 8.

Mon. U. S. G. S. No. 16, 1889, p. 119, pl. 20, figs. 4, 4a.

*Occurrence.*—In the Catskill beds of Cattaraugus County, N. Y. and Tioga County, Pa. and reported by Mr. C. Butts (Bul. N. Y. State Mus. No. 69, p. 994) from between the Wolf Creek and Salamanca conglomerates.

### SAGENODUS

**Sagenodus** sp. Eastman Plate 58, fig. 12.

Mon. N. Y. State Mus. No. 10, 1907, p. 160, pl. 1, fig. 13.

*Occurrence.*—In the 'Chemung beds' at Warren, Pa.

### CLADODUS

**Cladodus carinatus** Newb.

Mon. U. S. G. S. No. 16, 1889, p. 103, not illustrated.

*Occurrence.*—This is a rather indefinite species occurring among many other indefinable fragments at Warren, Pa. in what Dr. Newberry termed the 'Fish beds'.

### HELIODUS

**Heliodus gibberulus** Ag.

Mon. U. S. G. S. No. 16, 1889, p. 102, not illustrated.

This species was originally described from the Carboniferous limestones of Ireland and specimens very close to this species have been collected on the Miller farm in the Waverly beds on Oil Creek, Pa. None of the Pennsylvania specimens seem to have ever been pictured.

**Helodus comptus** Eastman
Ann. Carneg. Museum. Pittsburg, Vol. V, 1909, p. 488.

This species is known only from teeth which were discovered in the upper limestone (base of the Waverly) at Meadville, Penna. This species seems to have never been illustrated.

## AMPHIBIANS

### THINOPUS

**Thinopus antiqus** Marsh Plate 59, figs. 8, 9.

Am. Journ. of Sc. vol. 2, 1892, p. 374, Ill.
Am. Journ of Sc. (5) 71; voll. 12, p. 409, Ill.

This foot-track from the upper Devonian is the earliest stratigraphic record yet discovered of vertebrate life higher than fishes. Previous to this discovery the remains of Amphibians from the Carboniferous beds were the earliest known records of terrestrial vertebrates.

For an able discussion of the significance of this track and a reconstruction of the Amphibian foot see the paper by Mr. D. J. Morton, the second reference cited above.

*Occurrence.*—Found in the town of Pleasant, one mile south of the Allegany river, Warren County, Pa. The geological horizon is near the top of the 'Chemung group' in the Devonian. In the same beds are ripple marks, mudcracks and impressions of rain drops, indicating shallow water and shore deposits. Land plants are found in the same general horizon. Marine mollusks also occur, and one characteristic form, (*Nuculana*) is preserved in the foot-print slab.—From Marsh.

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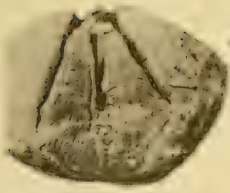
## EXPLANATION OF PLATE 2 (23)

FIGURE

1. **Reticularia præmatura** (Hall). From the Oswayo formation (?) ¾ miles east of the monument at Cobham, Pa. Width 37 mm. P. 59.
2. **Spirifer disjunctus** Sowerby. Chemung beds at Black Creek, Hudson tp. Allegany co. N. Y. nat size. P. 27.
3. **Spirifer disjunctus** Sowerby. Buff colored sandstone from the Venango First Oil Sand horizon near Glade, Pa. nat. size.
3. **Spirifer disjunctus** Sowerby. Same horizon as Fig. 3; 3 miles southwest of Warren, Pa. 31 mm. wide.
5. **Reticularia præmatura** (Hall). Showing the large muscular impression. The Owayo formation ¾ miles east of Glade, Pa.
6. **Spirifer disjunctus** Sowerby. Internal pedicle valve. From the Venango First Oil Sand at Glade, Pa. Width 52 mm.
7. **Spirifer disjunctus** Sowerby. Buff colored sandstone 100 feet above the road at Glade, Pa. nat. size.
8. The same from the same faunule as fig. 7. nat. size.
9. **Spirifer disjunctus** Sowerby. External cast of a portion of the cardinal area. Same faunule as Fig. 7. Length of specimen 16 mm.
10. The same from the horizon of Fig. 6, 3 miles southeast of Warren, Pa.



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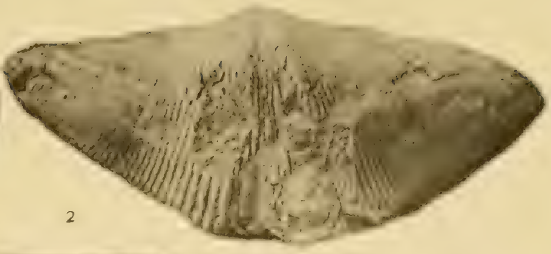

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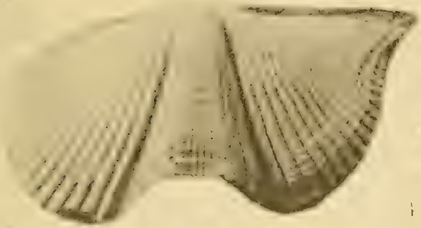

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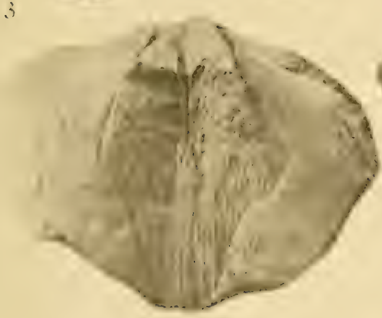

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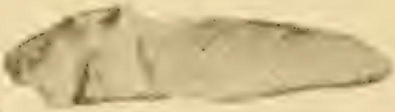

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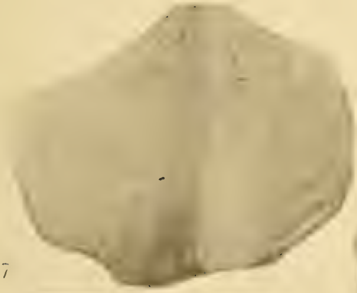

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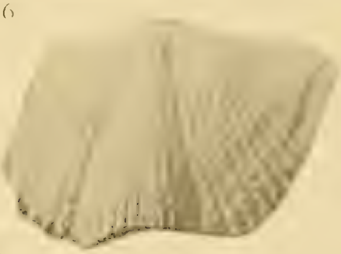

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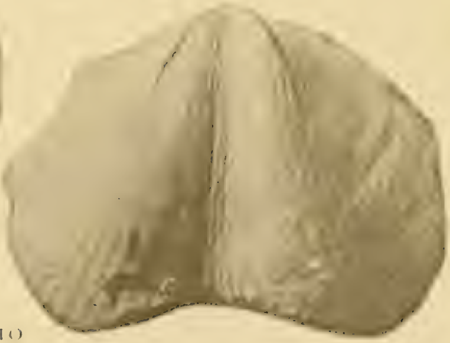

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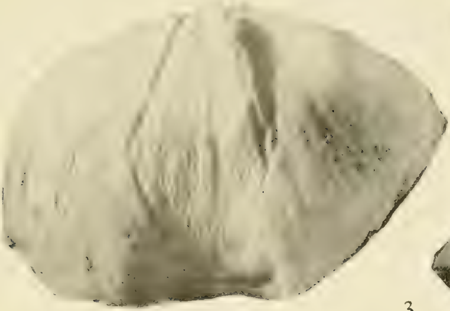
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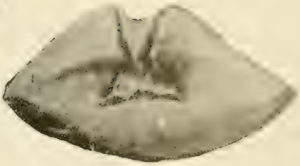
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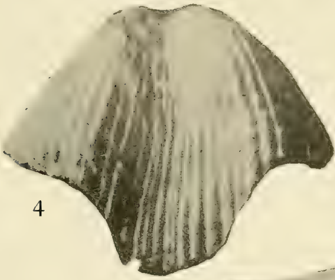
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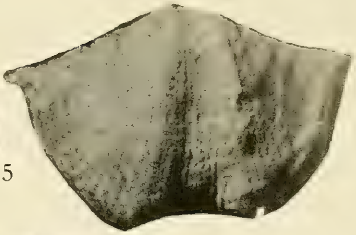
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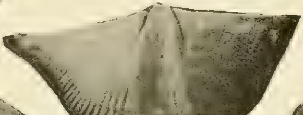
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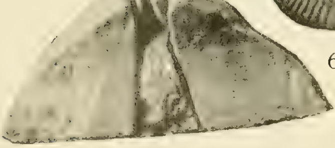
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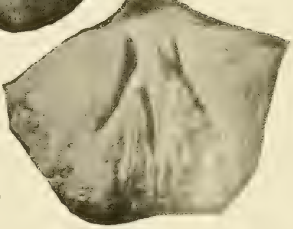
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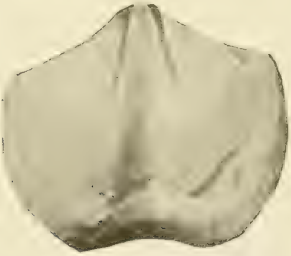
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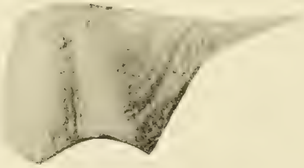
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## Explanation of Plate 3 (24)

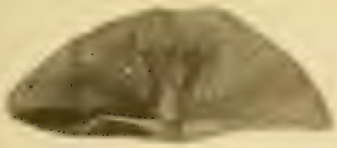
FIGURE

1. **Reticularia præmatura** (Hall)?. Three-fourths of a mile east of the monument at Cobham, Pa. Matrix a buff sandstone. Width 40 mm. P. 59.
2. **Spirifer disjunctus** Sowerby. From the Oswayo at Glade, Pa. With of Specimen 25 mm. P. 27.
3. The same. From the Conewango formation at Glade, Pa. Width 33 mm.
4. The same. From the middle Conewango formation at Pope Hollow, N.Y. nat. size.
5. **Spirifer disjunctus** Sowerby. From the same faunule at Fig. 2. Width 45 mm.
6. The same. The Venango First Oil Sand horizon just east of the Cobham monument. Width 36 mm.
7. **Cyrtia alta** (Hall) same faunule as Fig. 3. Width 40 mm. P. 52.
8. **Reticularia præmatura** (Hall). Same faunule as Fig. 1. nat size.
9. **Spirifer disjunctus** Sowerby. Ventral view of Fig. 3.
10. The same. Same faunule as Fig. 2. Width of specimen 33 mm.

## EXPLANATION OF PLATE 4 (25)

FIGURE

1. **Spirifer allegheniensis** n. sp. 'Venango first oil sand,' Stone Hill, near Stoneham, Pa. Width 32 mm. P. 50.
2. **Spirifer allegheniensis** n. sp. Showing internal coils. Same faunule as Fig. 1. Width 36 mm.
3. **Spirifer allegheniensis** n. sp. Same faunule as Fig. 1. Width 34 mm.
4. **Spirifer allegheniensis** n. sp. Dorsal view of Fig. 3.
5. **Spirifer allegheniensis** n. sp. Same faunule as Fig. 1. Width 29 mm.
6. **Spirifer allegheniensis** n. sp. Width 35 mm.
7. **Spirifer disjunctus** var. **sulcifer** Hall. Locality same as for Fig. 1. Width 36 mm. P. 49.
8. Ventral view of Fig. 7.
9. **Spirifer allegheniensis** n. sp. Width 30 mm.
10. Ventral view of Fig. 9.
11. Dorsal view of Fig. 9.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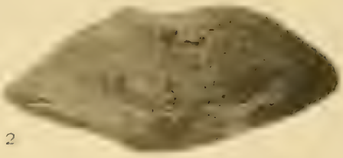
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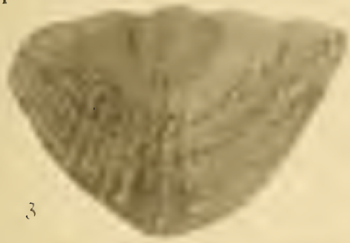
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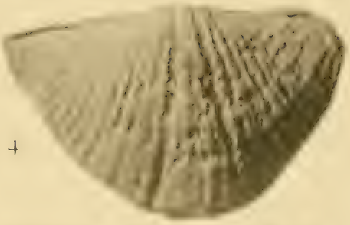
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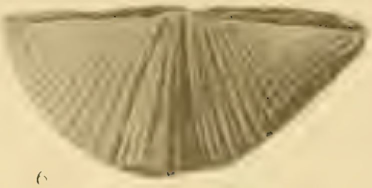
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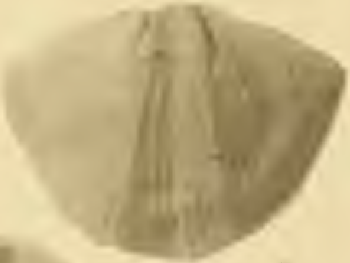
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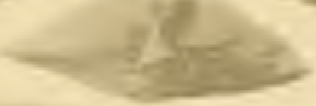
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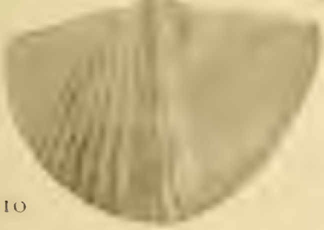
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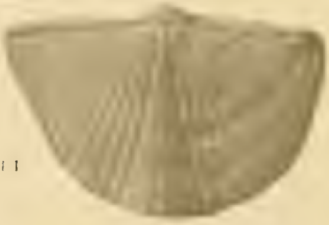
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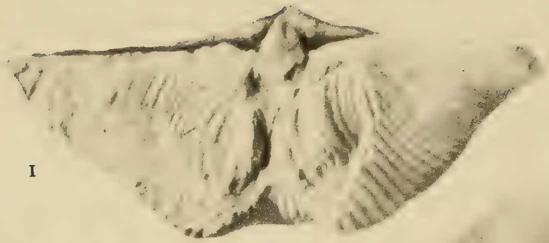

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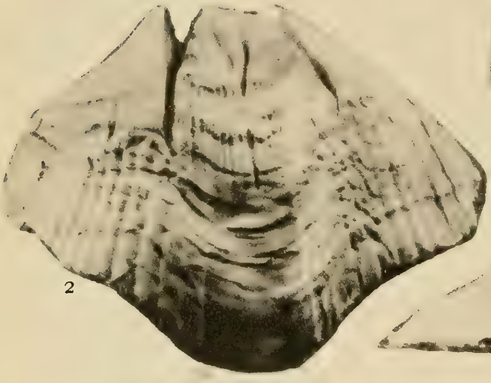

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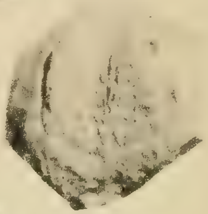

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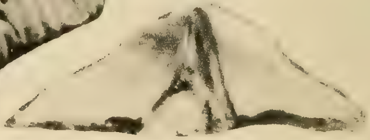

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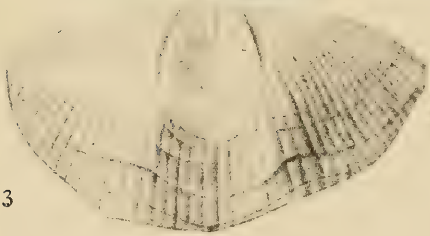

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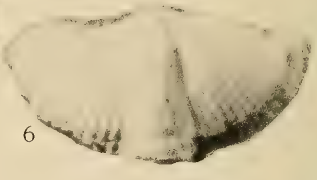

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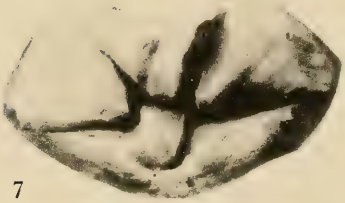

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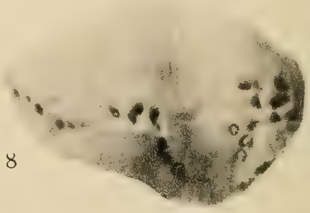

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## EXPLANATION OF PLATE 5 (26)

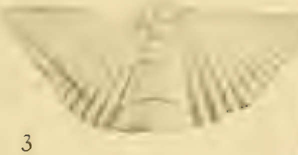
FIGURE

1. **Spirifer disjunctus** Sowerby. Showing the spiral coils. The upper Chemung beds at Black Creek, Allegany County, N. Y. Width 63 mm. P. 27.
2. **Syringothyris angulata** Simpson. Venango First Oil Sand; Stone Hill, near Stoneham, Pa. Width 50 mm. P. 52.
3. **Syringothyris randalli** Simpson. Original illustration for comparison with the type of **Syringothyris** found near Warren. From Tr. Am. Phil. Soc. n. s. 16, 1889, p. 441. P. 52.
4. **Syringothyris angulata** Simpson. A well developed muscular impression. Coarse pebble conglomerate associated with the Venango First Oil Sand at Stone Hill, near Stoneham, Pa., nat. size.
5. The same. Same faunule at Fig. 4. Width 36 mm.
6. **Spirifer disjunctus** Sowerby. Showing a strong peripheral impression. Basal Conewango at Stoneham, Pa. Width 41 mm.
7. **Reticularia præmatura** (Hall). Cardinal view of Fig. 5, plate 2.
8. **Spirifer disjunctus** Sowerby. Probably a pathologic specimen. P. 59.

## EXPLANATION OF PLATE 6 (27)

FIGURE

1. **Syringothyris angulata** Simpson. P. 52.
1. Photomicrograph of an external cast showing the characteristic "twilled cloth" structure. Venango First Oil Sand on Stone Hill, near Stoneham, Pa.
2. Surface ornamentation under higher magnification.
3. **Syringothyris** ? sp. From the faunule of Fig. 1. Width 39 mm.
4. **Syringothyris angulata** Simpson. An unusually pustulose individual. From the faunule of Fig. 6. Width 38 mm.
5. The same. A specimen with a deformed syrinx. The same faunule as Fig. 1. nat. size.
6. A specimen showing an apparently solid syrinx. From the Venango First Oil Sand at Cobham, Pa.; approx. nat size.
7. A specimen showing the posterior mesial carina of the mold and the ventrally split syrinx. Two miles west of Smethport, Pa. Width 42 mm.
8. The syrinx of this specimen was evidently attached directly to the internal ventral surface of the shell. Same faunule as Fig. 6. Height of specimen about 32 mm.
9. **Spirifer disjunctus** ?. From above the Sub Olean conglomerate at Cobham, Pa.; nat size. P. 47.
10. **Spirifer disjunctus** Sowerby from the Venango First Oil Sand horizon one mile east of Stoneham, Pa.



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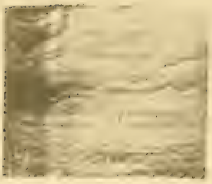

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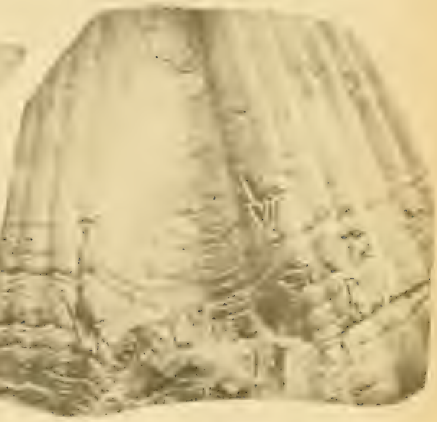

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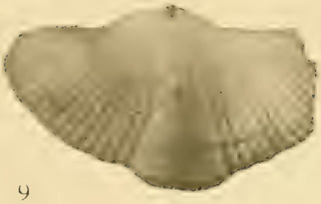

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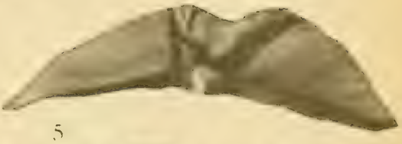

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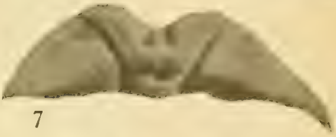

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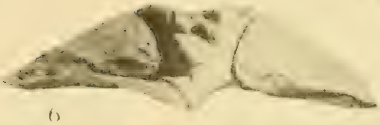

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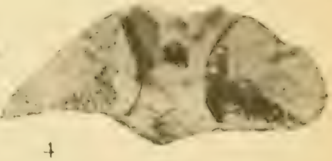

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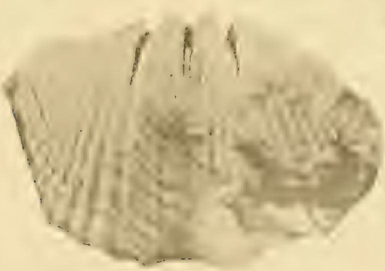

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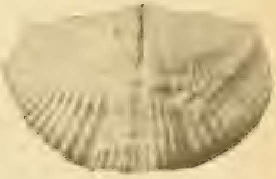

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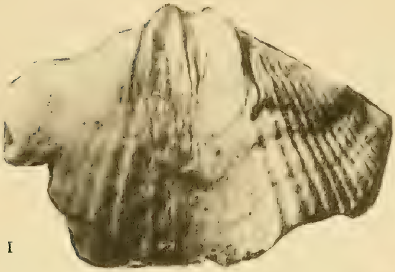

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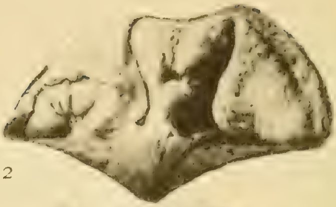

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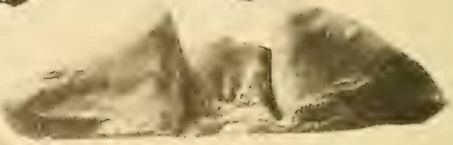

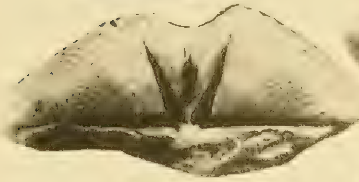

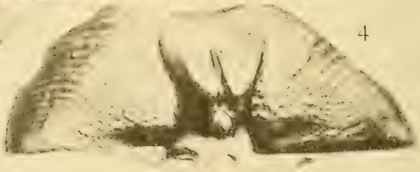

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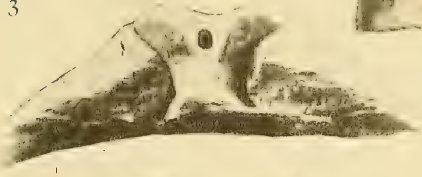

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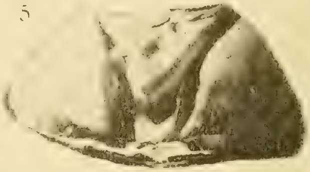

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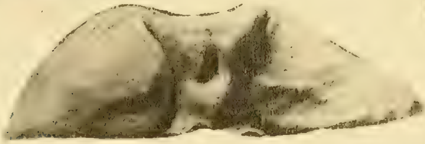

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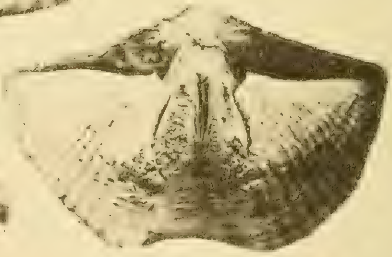

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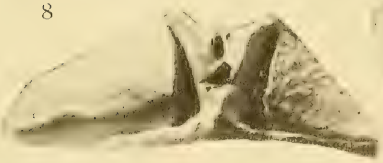

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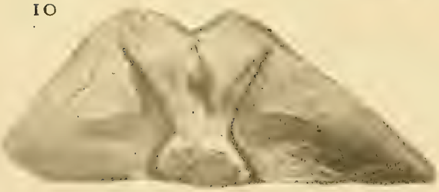

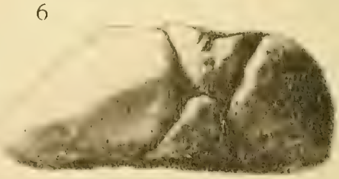

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## EXPLANATION OF PLATE 7 (28)

FIGURE

**1-12. Syringothyris angulata** Simpson. P. 32.

1. Ventral valve of a specimen from the conglomerate associated with the Venango First Oil Sand at Stoneham, Pa. Width 45 mm.
2. From the same faunule as Fig. 1. Width 34 mm.
3. An interesting syringeal development. Width 42 mm.
4. Typical of many specimens from the faunule of Fig. 1.
5. One stage farther along than that shown by Fig. 1, in the ventral attachment of the syrinx. Width 47 mm.
6. Ventro-cardinal view of Fig. 5.
7. From the same faunule as Fig. 1. Width 50 mm.
8. From the Venango First Oil Sand horizon at Stoneham, Pa. Width 51 mm.
9. A mal-formed specimen from the faunule of Fig. 1. Width about 32 mm.
10. Cardinal view of Fig. 1.
11. From the same locality as Fig. 8. Width 48 mm.
12. A peculiar syrinx with an inverted T-shaped invagination on the ventral side. Faunule the same as for Fig. 1. Width 43 mm.

## EXPLANATION OF PLATE 8 (29)

FIGURE

1-10. **Syringothyris angulata** Simpson. P. 32.

1-3. From the illustrations accompanying the original description of the species. Tr. Am. Phil. Soc., n. s. 16, 1889. p. 440.

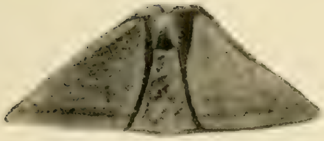
4. From the Venango First Oil Sand at Stoneham, Pa. Width 30 mm.

5. An extreme development of the muscle impression. About a mile east of the Cobham monument, the same horizon as Fig. 4. Width about 42 mm.

6. A primitive syrinx which is split slightly toward the front. From the faunule of Fig. 4. Width 41 mm.

7, 8. From the faunule of Fig. 4. Nat. size.

9, 10. From the chocolate colored shales 2 miles west of Smethport, Pa., in a cut along the mountain on a spur railroad. Nat. size.



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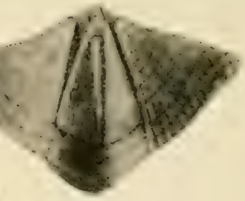

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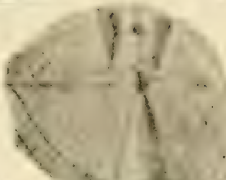

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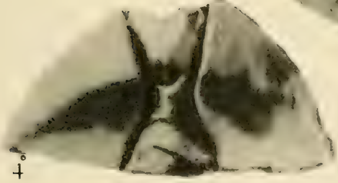

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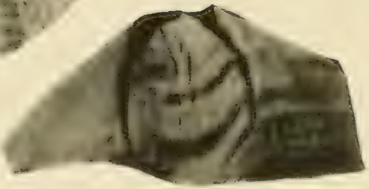

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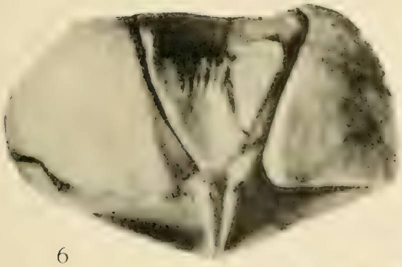

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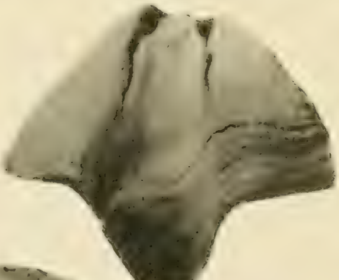

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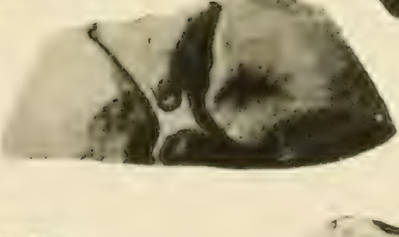

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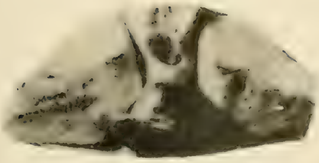

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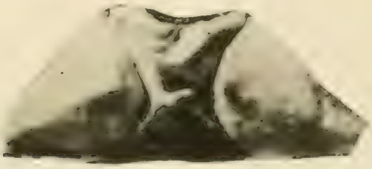

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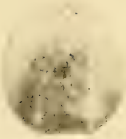
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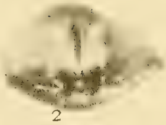
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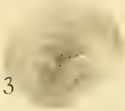
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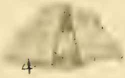
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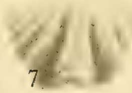
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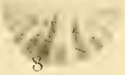
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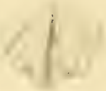
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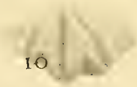
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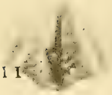
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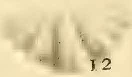
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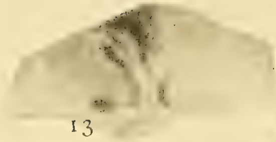
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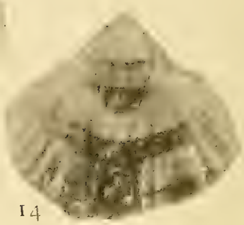
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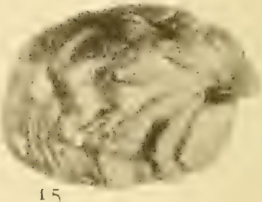
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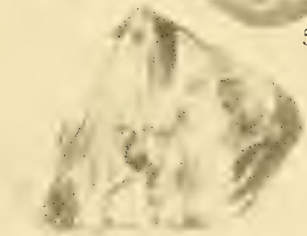
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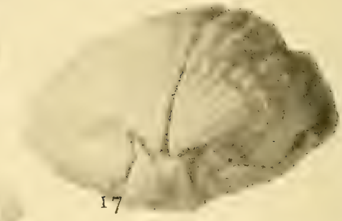
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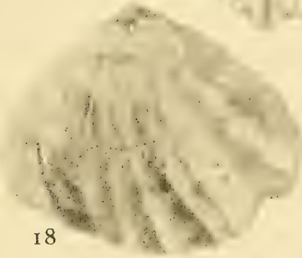
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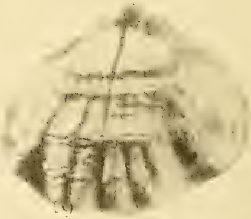
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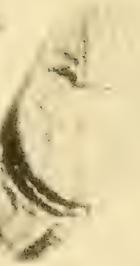
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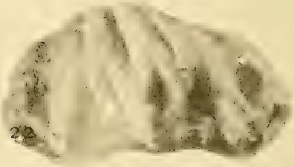
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## EXPLANATION OF PLATE 9 (30)

FIGURE

1. **Athyris angelica** Hall, nat. size. P. 35.
2. **Athyris angelica** Hall, nat. size.
3. **Athyris angelica** Hall. Venango First Oil Sand at Stone Hill, near Stoneham, Pa., nat. size.

4-12. **Cyrtina triplicata** Simpson. From the same faunule as Fig. 1, x 2. P. 19.

13. **Paraphorhynchus** sp. From the Venango First Oil Sand horizon at Cobham, Pa. P. 21.
14. **Paraphorhynchus medialis** (Simpson). From a conglomeritic sandstone at the Venango First Oil Sand horizon just east of the monument at Cobham, Pa. P. 22.
15. **Paraphorynchus girtyi**, n. sp. From Venango First Oil Sand horizon between Scania and Smethport, Pa. x7-5. P. 23.
16. **Paraphorhynchus striata** (Simpson). From the faunule of Fig. 1. Greatest width 36 mm. P. 24.

17-19. **Paraphorhynchus girtyi** n. sp. Different views of Fig. 15.

20. **Paraphorhynchus striata** (Simpson)? Same faunule as Fig. 1. Width 30 mm.
21. **Paraphorhynchus medialis** (Simpson). An enlargement of a portion of an external cast. Faunule of Fig. 1. P. 22.
22. **Paraphorhynchus girtyi**, n. sp. Another view of Fig. 15.

## EXPLANATION OF PLATE 10 (31)

FIGURE

1. **Orbiculoidea** sp. Impression of an external cast from the Venango First Oil Sand 3 miles southeast of Warren, Pa. nat. size. P. 5.
2. **Orbiculoidea** sp. The external cast from which Fig. 1 was made.
3. **Orbiculoidea** sp. From the Oswayo sandy shales 2 miles west of Smethport, Pa. In a railroad cut. nat. size.

4, 5. **Orbiculoidea** sp. From the Venango First Oil Sand horizon at Glade, Pa.

6. **Chonetes setigerus** (Hall). From just above the Sub Olean conglomerate 1 miles east of Stoneham, Pa. x9-7. P. 8.
7. **Orthothetes crenistria** (Phillips?). From the Venango First Oil Sand horizon at Cobham, Pa. x 2., P. 7.
8. **Chonetes setigerus** (Hall). Same faunule as Fig. 6.
9. **Dalmanella leonensis** Hall ?. From the Conewango formation at Glade, Pa., slightly reduced. P. 8.
10. **Spirifer** sp. ?. From the Conewango formation near Warren, Pa. x1¼.

11, 12. **Ambocœlia gregaria** Hall. The same horizon as Fig. 6, and at Stoneham, Pa. x 1¼. P. 38.

13. **Lingula cuyhoga** Hall. From Pal. of N. Y., viii, i, 1892, pl. 1, fig. 18. P. 5.
14. **Lingula ligea** Hall. From Pal. of N. Y., iv, 1867, pl. 1, fig. 2a. P. 5.
15. **Idem** fig. 5.
16. **Idem** fig. 2.
17. **Crania leoni** Hall. From Pal. of N. Y., iv, 1867, pl. 3, fig. 30. P. 6.
18. **Idem** fig. 29.
19. **Lingula delia** Hall. From Pal. of N. Y., viii, i, 1892, pl. 1, fig. 29. P. 5.
20. **Crania leoni** Hall. Pal. of N.Y., iv, 1867, pl. 3, fig. 28.
21. **Lingulodiscina pleurites** (Meek). From Pal. of N. Y., viii, i, 1892, pl. 4e, fig. 23. P. 5.
22. **Idem** fig. 21.
23. **Idem** fig. 24.
24. **Orbiculoidea allegania** (Hall). From Pal. of N. Y., iv, 1867, pl. 1, fig. 17a. P. 5.
25. **Lingula scutella** Hall. From Pal. of N. Y., viii, i, 1892, pl. 1, fig. 30. P. 4.
26. **Orbiculoidea allegania** (Hall). Pal. of N. Y., iv., 1867, pl. 1, fig. 17b.
27. **Idem** fig. 17c.
28. **Crania** cf. **leoni** Hall. From the Oswayo sandstone, near Olean Rock City, N. Y. nat. size.
29. Another view of Fig. 28.

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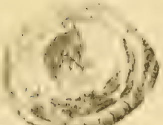
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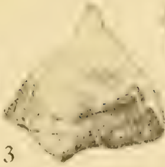
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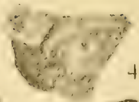
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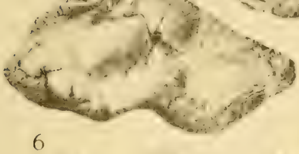
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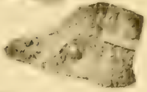
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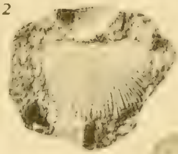
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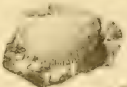
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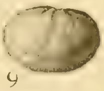
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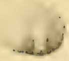
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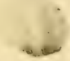
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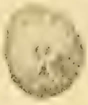
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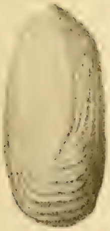
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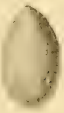
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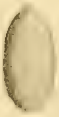
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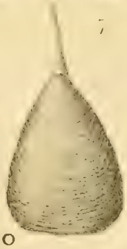
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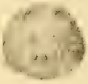
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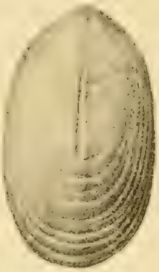
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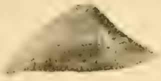
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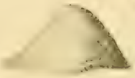
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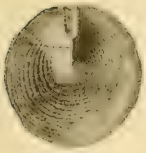
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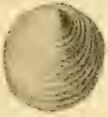
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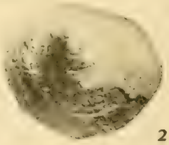
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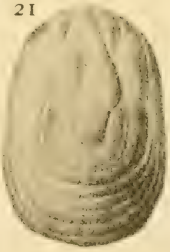
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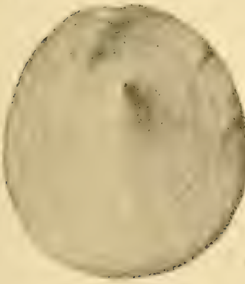
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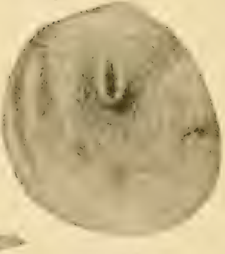
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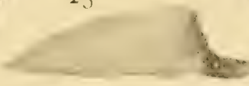
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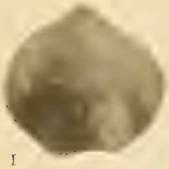
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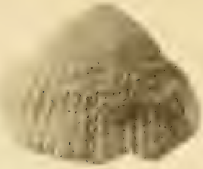
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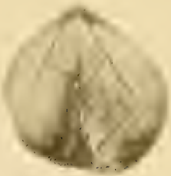
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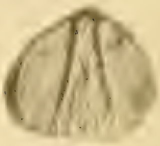
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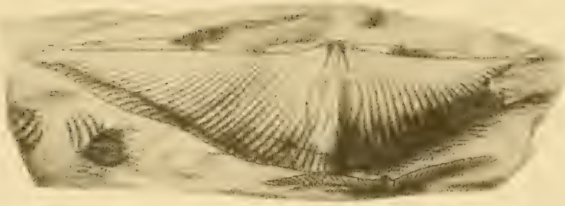
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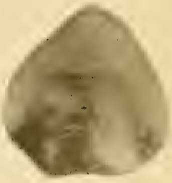
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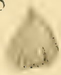
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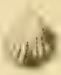
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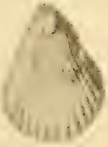
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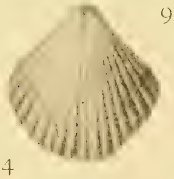
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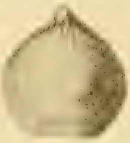
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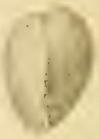
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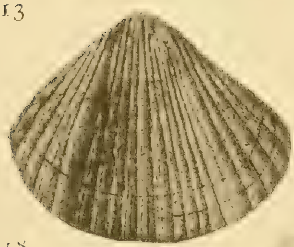
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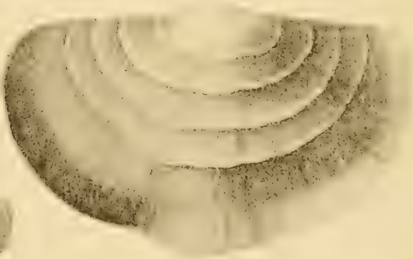
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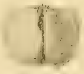
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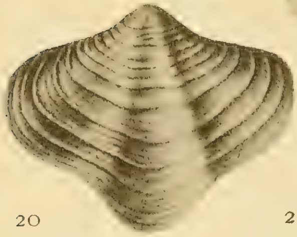
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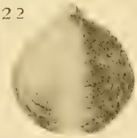
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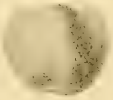
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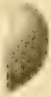
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## EXPLANATION OF PLATE 11 (32)

FIGURE

1. **Athyris angelica** Hall. From the Cattaragus beds of Chautauqua county, N. Y. Width about 20 mm. P. 35.
2. **Rhynchospirina scansa** (Hall). Oswayo formation; 2 miles west of Smethport, Pa., in a railroad cut along a spur line, nat size. P. 39.
3. **Reticularia præmatura** (Hall). Venango First Oil Sand horizon, near the Cobham monument, Pa. nat. size. P. 39.
4. **Idem.** From the very fossiliferous greenish sandstone on the west side of Robins Hill, near the top and just below a prominent conglomerate. nat. size.
5. **Spirifer disjunctus** Sowerby. From the original illustration of the speies. Tr. Geol. Soc. of London, 28nd series, V, 1830, pl. 53, fig. 11. P. 27.
6. **Athyris angelica** Hall. Same faunule as Fig. 1. nat size. P. 35.

7-12. **Retzia** or **Rhynchospirina** sp. Venango First Oil sand horizon, at Stneoham, Pa. Slightly enlarged. P. 39.

13. **Rhynchospirina** sp. (Hall)?. From Pal. of N. Y., viii, ii, 1894, pl. 50, fig. 44.
14. **Rhynchospirina scansa** (Hall). From Pal. of N. Y., viii, ii, 1894, pl. 50, fig. 45.

15-17, 21. **Athyris polita** of Hall. From Pal. of N. Y., iv. 1867, pl. 47, figs. 27, 25, 23. P. 35.

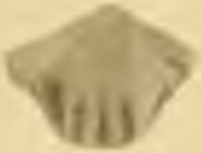
18. **Paraphorhynchus medialis** (Simpson). The illustration of the original description of the species. Tr. Am. Soc., n. h. 16, 1889, p. 444. P. 22.
19. **Athyris lamellosa** (L'eveille). From Pal. of N. Y., viii, ii, 1894, pl. 46, fig. 19. P. 36.
20. **Idem** fig. 18.

22-25. **Ambocœlia gregaria** (Hall). From Pal. of N. Y., iv, 1867, pl. 44, figs. 22, 19, 21, 20. P. 38.

## EXPLANATION OF PLATE 12 (33)

FIGURE

1. **Camarotœchia contracta** Hall. Gowanda, N. Y. Width 18 mm. P. 10.
2. **Idem.** Width 17 mm.
3. **Camarotœchia sappho** (Hall). Base of the Conewango formation on Stone Hill, near Stoneham, Pa. Width 18 mm. P. 15.
4. **C. contracta** (Hall). Ventral view of fig. 2.
5. **Idem.** Ventral view of fig. 2.
6. **Idem.** Dorsal view of fig. 2.
7. **C. sappho** (Hall). From the Marcellus shale at LeRoy, N. Y. Shown for comparison with upper Devonian specimens. Width 22 mm.
8. **C. sappho** (Hall?). From the Venango First Oil Sand one mile east of Stoneham, Pa. Width 23 mm.
9. **Idem.** From Gowanda, N. Y. Width 20 mm.
10. **Idem.** From the top of the Conewango, one mile east of Stoneham, Pa. Width 23 mm.
11. **C. contracta** (Hall). Anterior view of fig. 2.
12. **C. sappho** (Hall). Anterior view of fig. 7.
13. **Idem.** Dorsal view of fig. 7.
14. **Idem.** An unusually globular specimen from the base of the Conewango on Stone Hill, near Stoneham, Pa. Length 16 mm.
15. **Idem.** Ventral view of fig. 10.
16. **Idem.** Dorsal view of fig. 10.
17. **Idem.** Cardinal view of fig. 10.
18. **Idem.** From the Conewango formation 2 miles north of Warren, Pa.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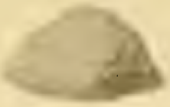
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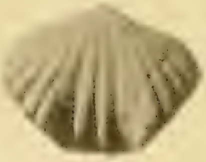
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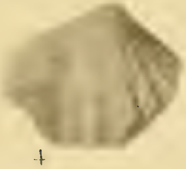
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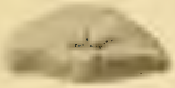
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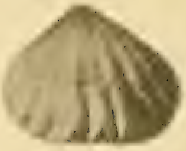
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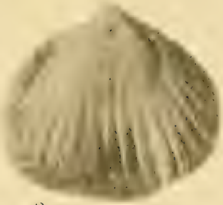
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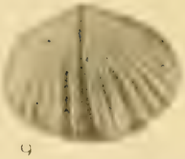
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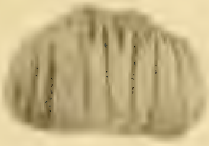
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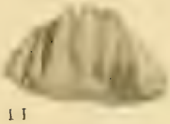
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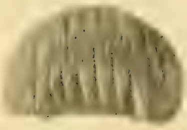
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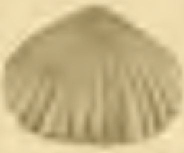
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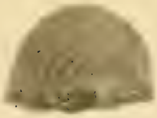
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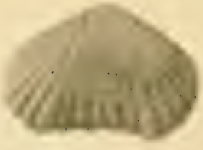
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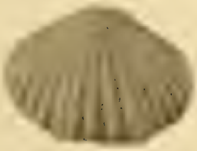
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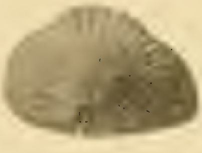
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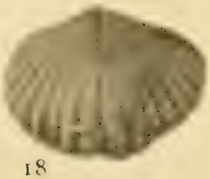
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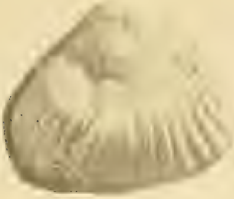

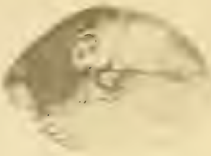

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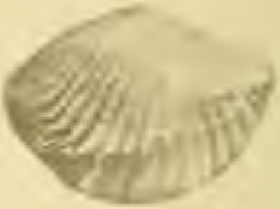

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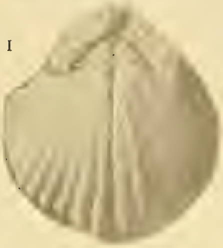

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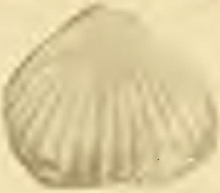

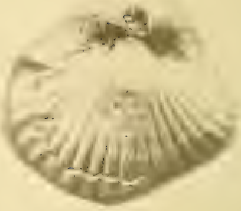

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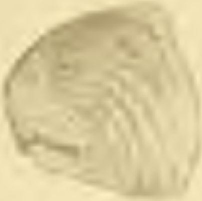

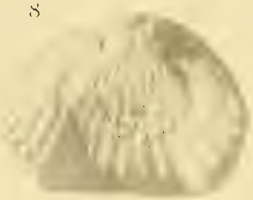

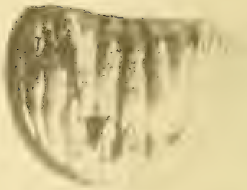

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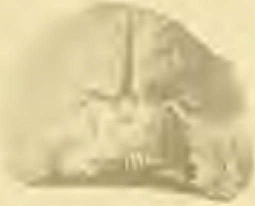

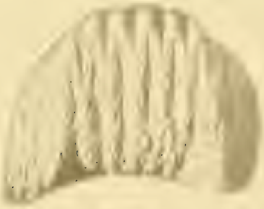

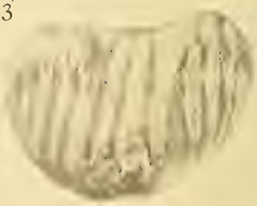

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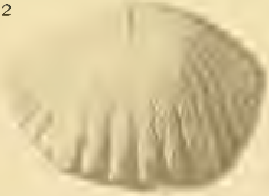

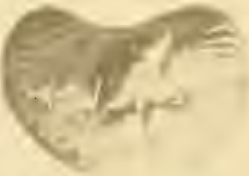

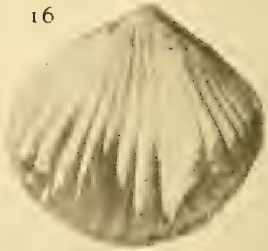

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## EXPLANATION OF PLATE 13 (34)

FIGURE

1-6. **Rhynchospirina scansa** (Hall). From the chocolate shales 2 miles west of Smethport, Pa., in a cut along a spur railroad. x 9/7 approx. P. 39.

7. **Camarotoechia sappho** (Hall). From the Conewango 2 miles north of Warren, Pa. P. 15.

8. **Idem.** From a light brown quartzitic sandstone just west of Kinzua, Pa.

10. **Idem.** Ventral view of fig. 9.

11. Anterior view of fig. 9.

12. Cardinal view of fig. 9.

13. **Idem.** Conewango at Gowanda, N. Y., Width 21 mm.

14. **Idem.** Dorsal view of fig. 13.

15. Cardinal view of fig. 13.

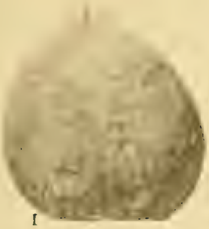
16. **C. sappho** (Hall). From the same faunule as fig. 13. Width 24 mm.

17. Ventral view of fig. 16.

## EXPLANATION OF PLATE 14 (35)

FIGURE

1. **Camarotœchia allegania** (Wms.). Dorsal view of an extra large specimen from the Oswayo beds as exposed along the Roosevelt highway one-half mile from Mt. Jewett on the road to Smethport. Length 21 mm. P. 13.
2. Ventral valve showing the large muscular platform and short dental lamellæ. The Oswayo beds, 2 miles west of Smethport, Pa., in a railroad cut. Width 21 mm.
3. **Camarotœchia** sp. From the Conewango at Stoneham, Pa. Width 12 mm.
4. **C. allegania** (Wms.). Oswayo, west of Kinzua, Pa. Height 20 mm.
5. Dorsal mold from the Oswayo sandstone on the road from Stickley to Bradford, Pa. Length 20 mm.
6. Oswayo. West of Kinzua, Pa. Height 18 mm.
7. Dorsal mold showing the impressions of the posterior crenulations and the well developed median septum. Oswayo at Kinzua, Pa. Width 16 mm.
8. Typical specimen from the Oswayo along the road from Stickley to Bradford, Pa. Length 17 mm.
9. Dorsal view of fig. 3.
10. **Camarotœchia** sp. Conewango at Stoneham, Pa. Width 9 mm.
11. Dorsal view of fig. 10.
12. **C. allegaina** (Wms.). Faunule of fig. 8. Length 21 mm.
13. **Idem.** Same faunule as fig. 4. Width 17 mm.
14. From the same faunule as fig. 8.
15. Same faunule as fig. 7. Width 21 mm.
16. **C. contracta** (Hall). From the Venango First Oil Sand horizon one mile east of Stoneham, Pa. Width 16 mm. P. 10.
17. **Idem.** Faunule of fig. 16. Width 16 mm.
18. Posterior view of fig. 17.
19. Ventral view of fig. 17.
20. Ventral view of fig. 16.
21. Anterior view of fig. 16.
22. **C. sappho?.** Same faunule as fig. 8. Length 18 mm.
23. **Camarotœchia contracta** (Hall). Faunule of fig. 16. Length 18 mm.
24. **Idem.** Width 13 mm.
25. **Idem.** Same faunule as fig. 24. Width 13 mm.
26. **Idem.** Faunule of fig. 16. Width 15 mm.
27. Ventral view of fig. 26.
28. **Idem.** Faunule of fig. 24. Width 14 mm.
29. Brachial valve of fig. 28.
30. Ventral view of fig. 23.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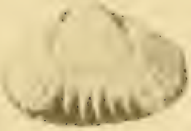
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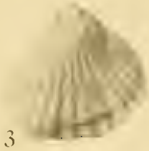
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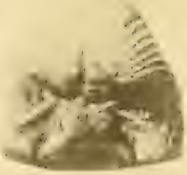
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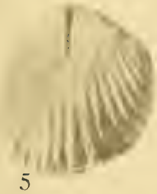
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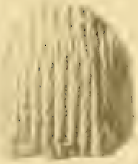
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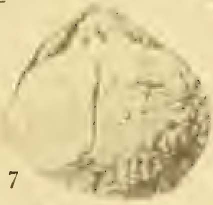
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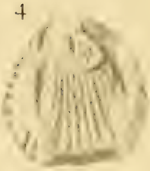
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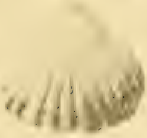
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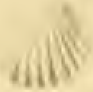
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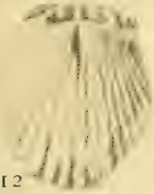
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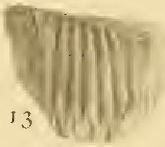
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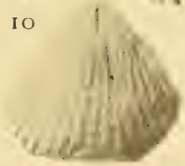
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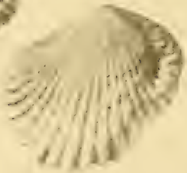
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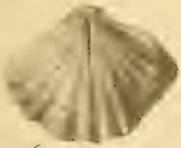
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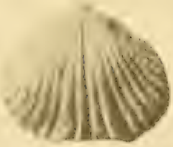
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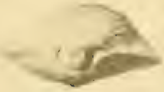
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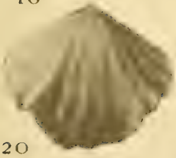
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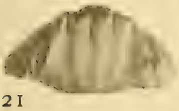
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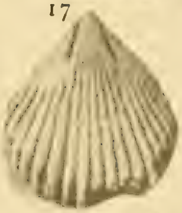
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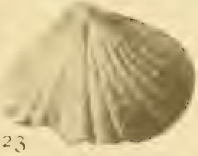
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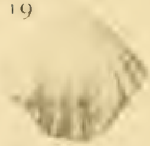
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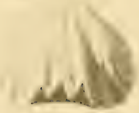
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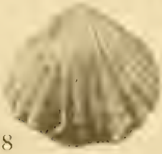
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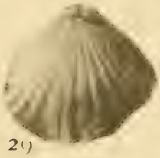
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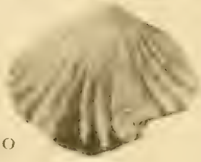
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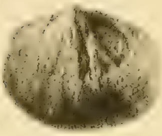
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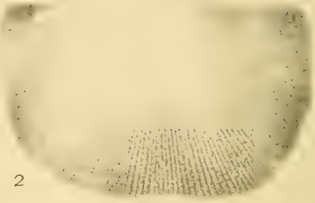
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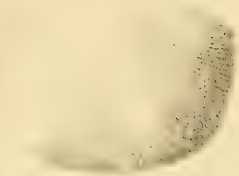
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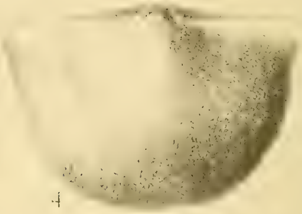
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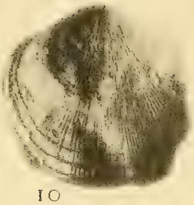
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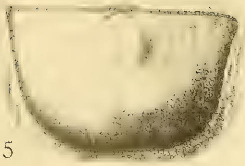
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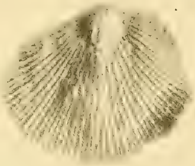
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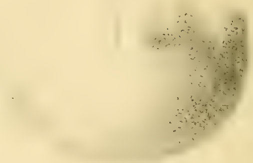
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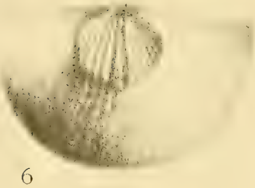
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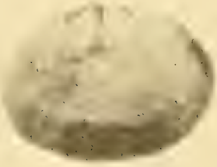
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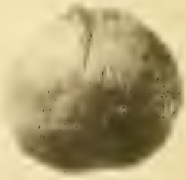
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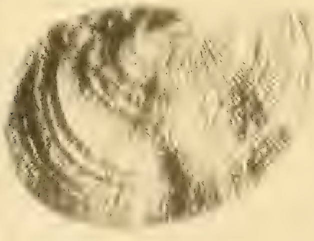
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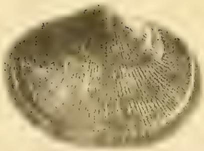
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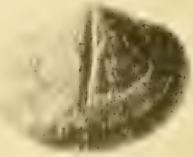
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## EXPLANATION OF PLATE 15 (36)

FIGURE

1. **Schuchertella chemungensis** (Conrad). From Hall, Pal. of N. Y., iv, 1867, pl. 10, fig. 8. P. 6.
2. **Idem** fig. 11.
3. **Idem** fig. 7.
4. **Stropheodonta demissa** (Hall). From Pal. of N. Y., iv, 1867, pl. 19, fig. 10. P. 9.
5. **Schuchertella chemungensis** (Conrad). From Pal. of N. Y., iv, 1867, pl. 10, fig. 19.
6. **Idem** fig. 21.
7. **Stropheodonta demissa** (Hall). Ibid. pl. 19, fig. 11.
8. **Schuchertella chemungensis** (Conrad). Ibid. pl. 10, fig. 9.
9. **Rhipidomella** sp. The Venango First Oil sand horizon east of the Cobham monument. nat. size. P. 8.
10. **Schuchertella** cf. **chemungensis.** An external cast. ¾ mile east of Cobham, Pa. nat. size.
11. **Orothothetes** sp. Same horizon as fig. 9, in a creek bed one mile east of Stoneham, Pa. nat. size. P. 7.

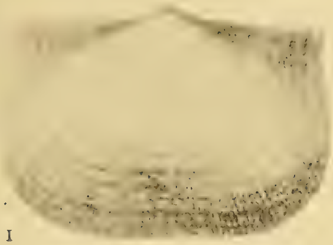
12, 13. **Schizophoria** sp. ?. Same faunule as fig. 9. nat. size. nat. size.

14. **Rhipidomella** af. **micheline** (Hall). From Conewango at Glade, Pa. P. 8.
15. **Schuchertella chemungensis.** Black Creek, Hudson twp., Allegany County, N. Y.
16. **Rhipidomella** sp. Same faunule as fig. 14. nat sinze.

## EXPLANATION OF PLATE 16 (37)

FIGURE

1. **Orthothetes crenistria** (Phillips?). From Herrick, Bull. Dennison Univ. iv, 1888, pl. 4, fig. 1. P. 7.
2. **Idem.** fig. 5.
3. **Strophalosia muricata** (Hall). From Pal. of N. Y., iv, pl. 22, fig. 30. P. 7.
4. **Idem.** fig. 34.
5. **Idem.** fig. 35.
6. **Idem.** fig. 33.
7. **Idem.** fig. 29.
8. **Idem.** fig. 36.
9. **Chonetes scitulus** Hall. From Pal. of N. Y., iv, 1867, pl. 22, fig. 7. P. 7.
10. **Chonetes lepidus** Hall. From Pal. of N. Y., iv, 1867, pl. 22, fig. 13. P. 8.
11. **Chonetes scitulus** Hall. Ibid. fig. 10. P. 7.
12. **Idem.** fig. 6.
13. **Idem.** fig. 9.
14. **Chonetes setigerus** Hall. From Pal. of N. Y., iv, pl. 22, fig. 4. P. 8.
15. **Idem.** fig. 1.
16. **Ibdem.** fig. 2.
17. **Idem.** fig. 3.
18. **Dalamanella tenuilineata** (Hall). From Pal. of N. Y., iv, 1867, pl. 8, fig. 8 P. 8.
19. **Rhipidomella leucosia** (Hall). From Pal. of N. Y. iv, 1867, pl. 8, fig. 10. P. 8.
20. **Dalmanella tenuilineata** (Hall). Ibid. fig. 4.
21. **Idem.** fig. 3.
22. **Rhipidomella leucosia** (Hall). Ibid. fig. 9.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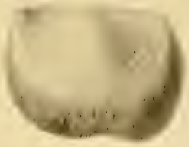
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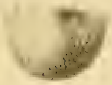
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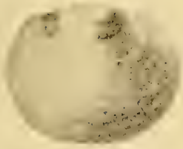
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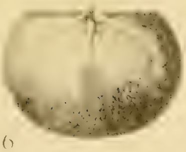
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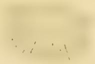
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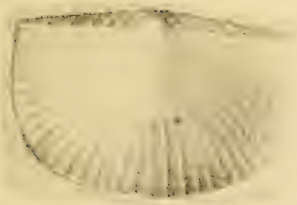
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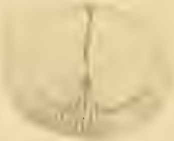
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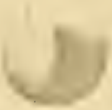
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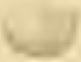
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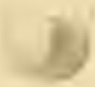
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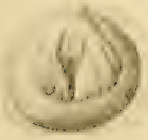
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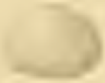
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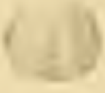
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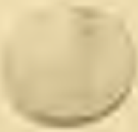
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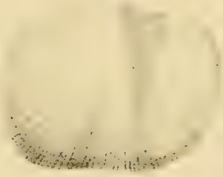

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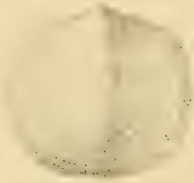

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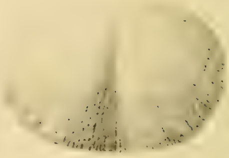

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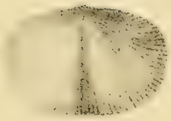

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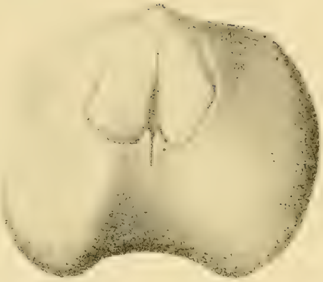

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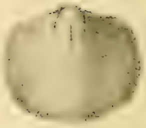

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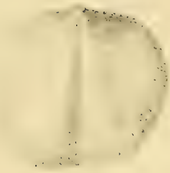

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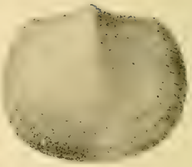

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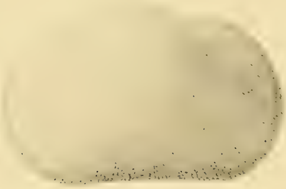

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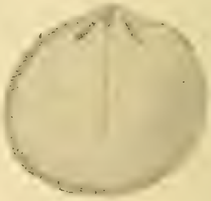

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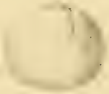

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16

## EXPLANATION OF PLATE 17 (38)

FIGURE

1. **Schizophoria tioga** (Hall). From Pal. of N. Y., iv, 1867, pl. 8, fig. 27. P. 9.
2. **Idem**, fig. 26.
3. **Idem.** fig. 22.
4. **Idem.** fig. 20.
5. **Schizophoria striatula** (Hall). From Pal. of N. Y., iv, 1867, pl. 8, fig. 12. P. 9.
6. **Schizophoria tioga** (Hall). Ibid. fig. 21.
7. **Schizophoria striatula** (Hall). Ibid. fig. 19.
8. **Idem.** fig. 15.
9. **Rhipidomella pennsylvanica** (Simpson). Tr. Am. Phil. Soc., n. s. 16, 1889, p. 437. P. 8.
10. **Idem.**
11. **Schizophoria striatula** (Hall). Pal. of N. Y., iv, 1867, pl. 8, fig. 13.
12. **Schizophoria tioga** (Hall). Ibid. fig. 28.
13. **Dalmanella tenuilineata** (Hall). Ibid. fig. 5.
14. **Idem.** fig. 7.
15. **Schizophoria striatula** (Hall). Ibid. fig. 11.
16. **Idem.** fig. 16.

## EXPLANATION OF PLATE 18 (39)

FIGURE

1-20. **Athyris angelica** Hall. P. 35.

1, 21. From the Venango First Oil sand horizon 1 mile east of Stoneham, Pa. nat. size.

3. From a yellow sandstone at Gowanda, N. Y. Width 19 mm.

4. From the faunule of fig. 1. Width 21 mm.

5. From the faunule of fig. 1. Width 18 mm.

6. Internal mold of fig. 1.

7. Same faunule as fig. 1. Width 26 mm.

8. Same faunule as fig. 1. Height 19 mm.

9. Dorsal mold from Gowanda, N. Y. Width 19 mm.

10. Ventral view of fig. 9.

11. From the faunule of fig. 1. Height 25 mm.

12. From the faunule of fig. 1. Length 19 mm.

13. Cardinal view of fig. 12.

14. From the faunule of fig. 1. nat. size.

15. Cardinal view of fig. 6.

16. The same horizon as fig. 1. Width 24 mm.

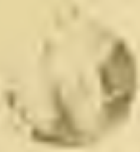
17. Same faunule as fig. 1. Width 21 mm.

18. From the faunule of fig. 3. Width 24 mm.

19. Same faunule as fig. 3. Width 19 mm.

20. Same faunule as fig. 3. Width 26 mm.

21. **Orthis** ? sp. From the Panama conglomerate at Panama Rocks, near Checkerboard School House. Length 21 mm.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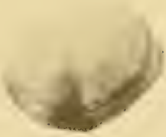
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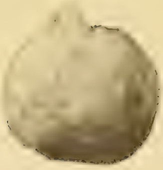
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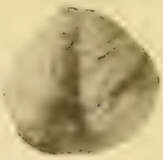
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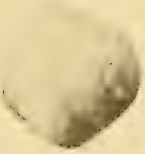
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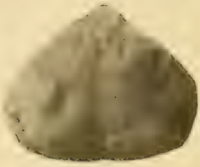
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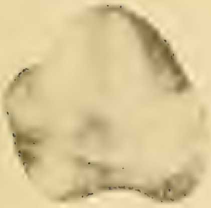
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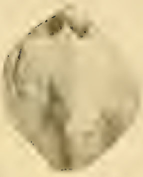
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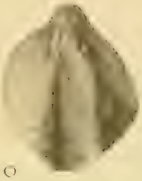
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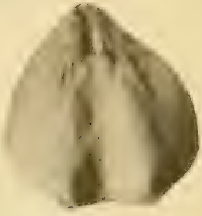
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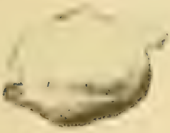
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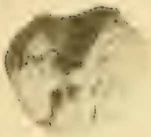
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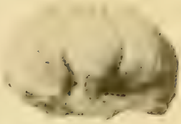
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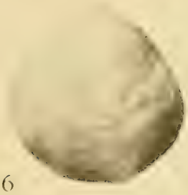
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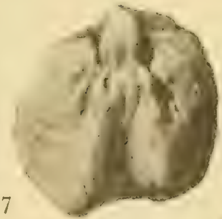
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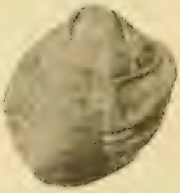
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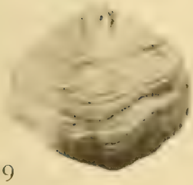
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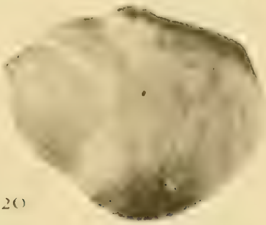
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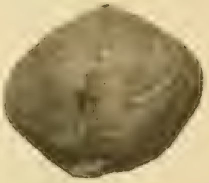
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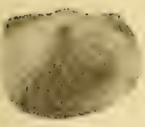
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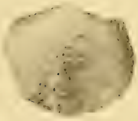
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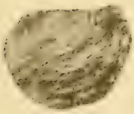
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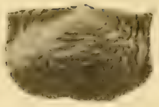
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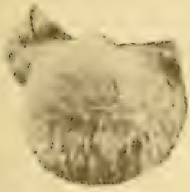
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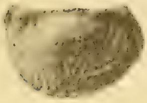
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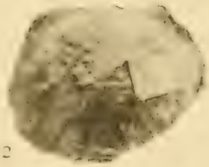
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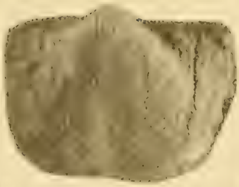
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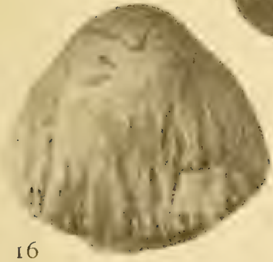
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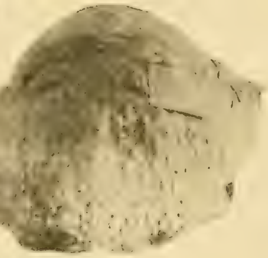
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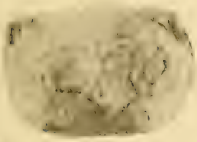
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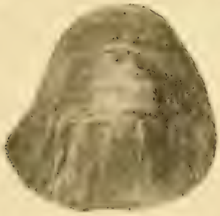
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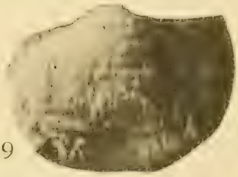
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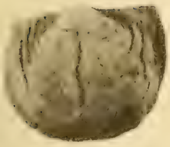
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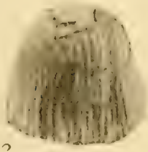
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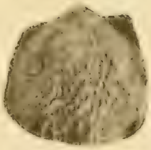
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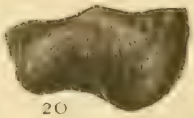
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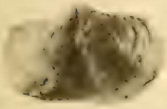
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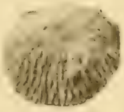
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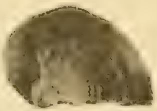
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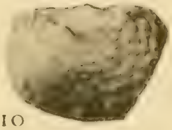
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## EXPLANATION OF PLATE 19 (40)

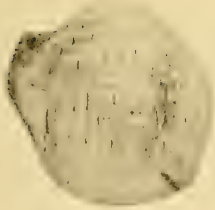
FIGURE

1. **Productella costatula** Hall. 'Chemung beds' at East Randolph, N. Y. N. Y. S. Mus. spec. No. 8082-1. P. 26.
2. **P. costatula** Hall. Chemung beds in Chemung county, N. Y. N. Y. S. Mus. spec. no. 8082-3.
3. Lateral view of fig. 1.
4. **Productella speciosa** Hall. 'Chemung beds,' New Albion, N. Y. N. Y. S. Mus. spec. no. 8092-2. P. 26.
5. **P. speciosa** Hall. 'Chemung beds,' Leon, N. Y. N. Y. S. Mus. spec no. 8092-1.
6. **P. speciosa** Hall. 'Chemung beds,' Cattaraugus county, N. Y. N. Y. S. Mus. spec. no. 8092-3.
7. **Productella acutirostris** Hall. 'Chemung beds' at Leon, N. Y. N. Y. S. Mus. spec. no. 8080-1. P. 26.
8. **Productella lachrymosa** (Conrad). 'Chemung beds,' Randolph, N. Y. N. Y. S. Mus. spec. no. 8086-4. P. 25.
9. **P. lachrymosa** (Conrad). 'Chemung beds' at Ellington, N. Y. N. Y. S. Mus. spec. no. 8086-5.
10. **P. lachrymosa** (Conrad). Same locality as fig. 9. N. Y. S. spec. no. 8086-1.
11. **Productella hirsuta**, var. **rectispina**. 'Chemung beds' at Meadville., Pa., N. Y. S. Mus. spec. no. 8085-1. P. 25.
12. **Productella lachrymosa**, var. **stigmata** Hall. 'Chemung beds' in Chautauqua county, N. Y. N. Y. S. Mus. spec. no. 8088-1. P. 25.
13. **P. l.** var. **stigmata** Hall. 'Chemung beds,' East Randolph, N. Y. N. Y. S. Mus. spec. no. 8088-3.
14. **Productella bialveata** Hall. 'Chemung beds.' at Meadville, Pa., N. Y. S. Mus. spec. no. 8081-4. P. 27.
15. **P. bialveata** Hall. Same faunule as fig. 14. N. Y. S. Mus. spec. no. 8081-1.
16. **Productus ?** sp. 'Chemung beds,' Cattaraugus county, N. Y. N. Y. S. Mus. spec. no. 8110-1.
17. **Productella onusta** Hall. 'Chemung beds' at Conewango, N. Y. N. Y. S. Mus. spec. no. 8090-5. P. 27.
18. **P. lachrymosa** var. **lima** Hall. 'Chemung beds' at Ellington, N. Y. N. Y. S. Mus. spec. no. 8072-2. P. 25.
19. **P. lachrymosa** var. **lima** Hall. 'Chemung beds' in Cattaraugus county, N. Y. N. Y. S. Mus. spec. no. 8087-1.
20. **B. lachrymosa** var. **lima**. On the slab with spec. no. 8087-3.
21. **P. lachrymosa** var. **lima** Hall. 'Chemung beds' at East Randolph, N. Y. N. Y. S. Mus. spec. no. 8087-3.

## EXPLANATION OF PLATE 20 (41)

FIGURE

1. **Productella lachrymosa var. stigmata** Hall. 'Chemung beds' at Conewango, N. Y. N. Y. S. Mus. spec. no. 8088-4. P. 25.
2. **P. lachrymosa var. stigmata** Hall. 'Chemung beds' at East Randolph, N. Y. N. Y. S. Mus. spec. no. 8088-3 P 27
3. **Productella bialveate** Hall. 'Chemung beds' at Meadville, Pa. On a slab with the other types of **P. bialveata.**
4. **P. bialveata** Hall. On the slab with fig. 3. N. Y. S. Mus. spec. no. 8081-5.
5. **Productella onusta** Hall. 'Chemung beds' at New Albion, N. Y. N. Y. S. Mus. spec. no. 8090-2. P. 27.
6. **P. onusta** Hall. 'Chemung beds' at Conewango, N. Y. N. Y. S. Mus. spec. no. 8090-4.
7. **P. onusta** Hall. Same locality as fig. 5. N. Y. S. Mus. spec. no. 8090-1.
8. **P. onusta** Hall. From the Chemung beds at Gowanda, N. Y.
9. **P. onusta** Hall. Venango First Oil sand, one mile east of Stoneham, Pa.
10. **Productella costatula** Hall. 'Chemung beds' at East Randolph, N. Y. N. Y. S. Mus. spec. no. 8082-2. P. 26.
11. **P. costatula** ?. From the same faunule as fig. 9.
12. **P. costatula** ?. Anterior view of fig. 11.
13. **P. costatula.** Same faunule as fig. 9.
14. **P. lachrymosa** (Con). Same faunule as fig. 9.
15. **Strophalosia histricula** (Hall). 'Chemung beds,' Conewango, N. Y. N. Y. S. Mus. spec. no. 8390-6. P. 27.
16. **Idem.** 'Chemung beds' near East Randolph, N. Y. N. Y. S. Mus. spec. no. 8390-4.
17. **Idem.** 'Chemung beds' near Conewango, N. Y. N. Y. S. Mus. spec. no. 8390-2.
18. **Idem.** 'Chemung beds' near New Albion, N. Y. N. Y. S. Mus. spec. no. 8390-3.
19. **Idem.** 'Chemung beds,' Leon, Cattaraugus county, N. Y. N. Y. S. Mus. spec. no. 8390-1.
20. **Idem.** 'Chemung beds' at Leon, N. Y. N. Y. S. Mus. spec. no. 8390-5.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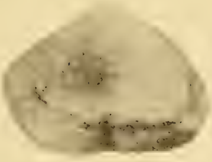
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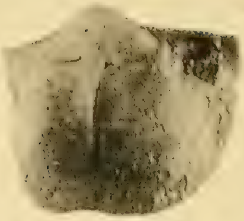
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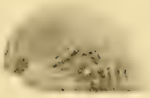
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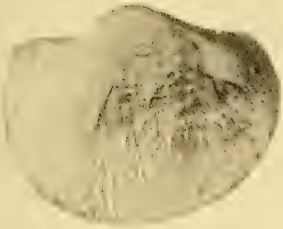
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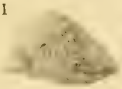
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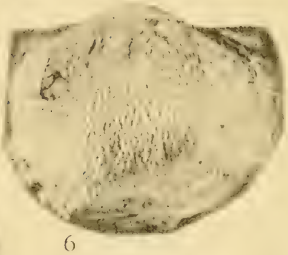
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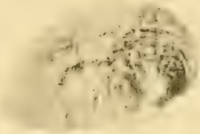
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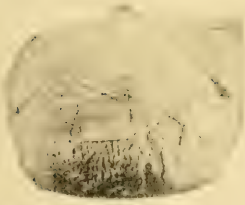
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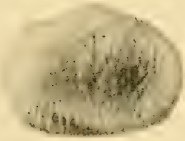
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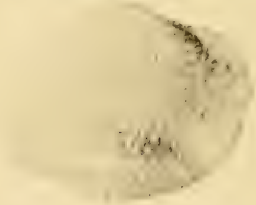
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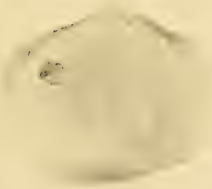
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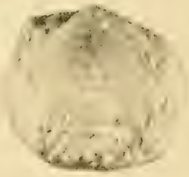
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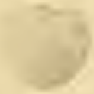
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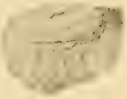
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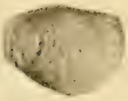
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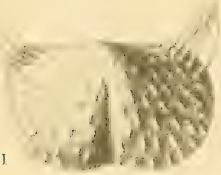
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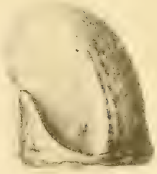
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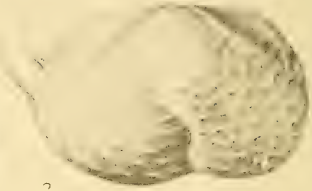
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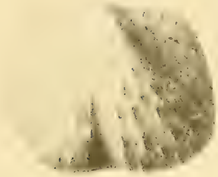
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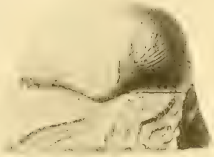
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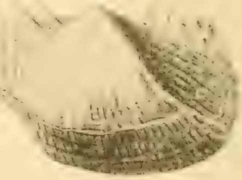
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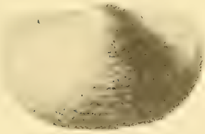
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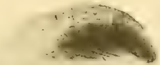
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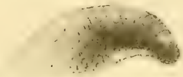
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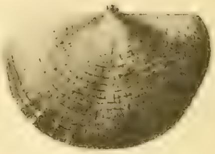
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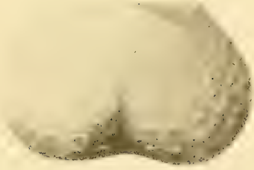
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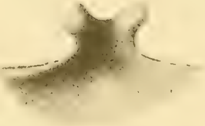
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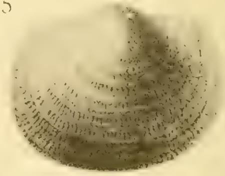
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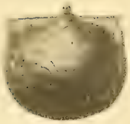
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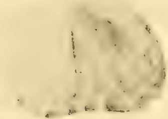
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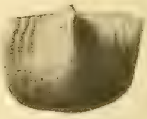
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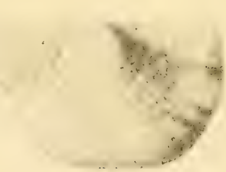
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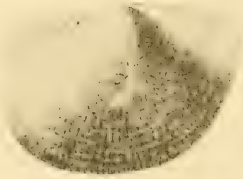
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## EXPLANATION OF PLATE 20a (41a)

FIGURE

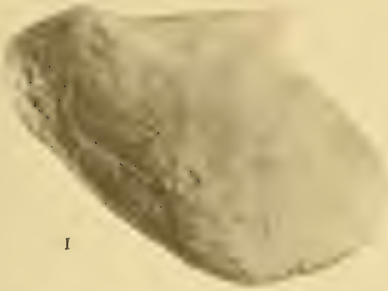
1. **Productella boydii** Hall. From the Pal. of N. Y., vol. iv, pl. 24, fig. 14.
2. **P. boydii.** Hall. Ibid. fig. 3.
3. **P. boydii.** Hall. Ibid. fig. 15.
4. **P. boydii** Hall. Ibid. fig. 12.
5. **P. boydii** Hall. Ibid. fig. 10.
6. **P. boydii** Hall. Ibid. fig. 11.
7. **Productella striatula** Hall. From Pal. of N. Y., iv, pl. 25, fig. 21. P. 27.
8. **P. striatula** Hall. Ibid. fig. 20.
9. **P. striatula** Hall. Ibid. fig. 14.
10. **P. striatula** Hall. Ibid. fig. 15.
11. **Productella hirsuta** Hall. From Pal. of N. Y., iv, pl. 24, fig. 26. P. 24.
12. **P. hirsuta** Hall. Ibid. fig. 18.
13. **P. hirsuta** Hall. Ibid. fig. 25.
14. **P. hirsuta** Hall. Ibid. fig. 23.
15. **P. hirsuta** Hall. Ibid. fig. 27.
16. **P. hirsuta** Hall. Ibid. fig. 22.
17. **P. hirsuta** Hall. Ibid. fig. 24.
18. **P. hirsuta** Hall. Ibid. fig. 20.
19. **P. hirsuta** Hall. Ibid. fig. 19.

## EXPLANATION OF PLATE 21 (42)

FIGURE

1. **Leptodesma potens** Hall. From the 'Chemung beds' at East Randolph, N. Y. N. Y. S. Mus. no. 9344-6. P. 45.
2. **Leptodesma mytiliforme** Hall. Upper 'Chemung beds' at Smethport, Pa. N. Y. S. Mus. no. 9338-1. P. 43.
3. **Leptodesma mentor** var. **rude** Hall. (**L. rude** Hall). From upper 'Chemung beds' at Smethport, Pa. N. Y. S. Mus. no. 9350-1. P. 51.
4. **Leptodesma potens** Hall. 'Upper Chemung beds' at Olean, N. Y. N. Y. S. Mus. no. 9344-4.
5. **Leptodesma potens**, var. **juvens** Hall. From the 'Chemung beds' at East Randolph, N. Y. N. Y. S. Mus. spec. no. 9345-1. P. 45.
6. **Leptodesma potens** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9344-3.
7. **L. potens** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9344-7.
8. **L. mentor** var. **orodes** Hall. (**L. orodes** Hall). In 'upper 'Chemung beds' on the road from Olean, N. Y., to Smethport, Pa. N. Y. S. Mus. spec. no. 9341-8. P. 50.
9. **Leptodesma potens** Hall. Same locality as fig. 1. N. Y. S. Mus. spec no. 9344-1.
10. **Leptodesma mentor** Hall. Same locality as fig. 3. N. Y. S. Mus. spec. no. 9336-1.
11. **Leptodesma matheri** Hall. Upper Chemung beds at Bradford, Pa. N. Y. S. Mus. spec. no. 9334-2.
12. **L. matheri** Hall. Same locality as fig. 11. N. Y. S. Mus. spec. no. 9334-3.
13. **L. mentor** var. **orodes** Hall. (**L. orodes** Hall). Same locality as fig. 8. N. Y. S. Mus. spec. no. 9341-2.
14. **L. mentor** Hall. Same locality as fig. 3. N. Y. S. Mus. spec. no. 9336-2.
15. **L. mentor** var. **orodes** Hall. (**L. orodes** Hall). Same locality as fig. 8. N. Y. S. Mus. spec. no. 9341-3.

All illustrations natural size.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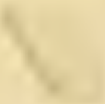
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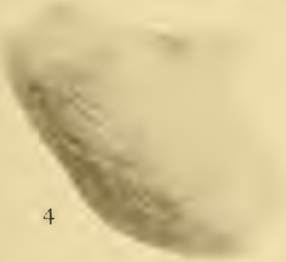
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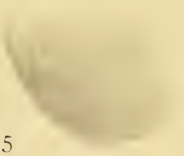
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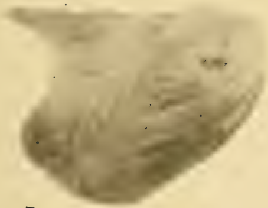
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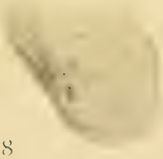
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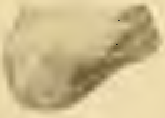
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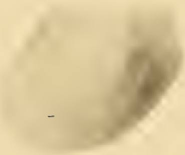
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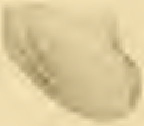
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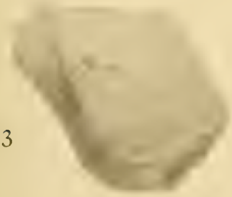
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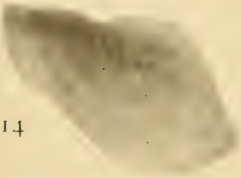
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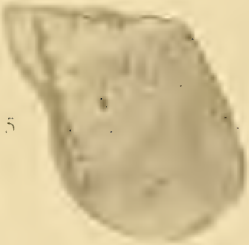
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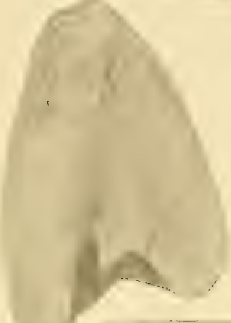
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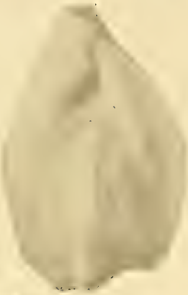
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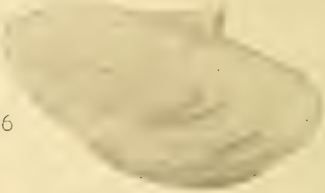
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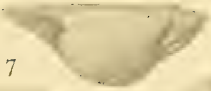
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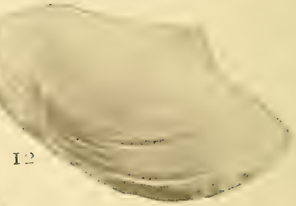
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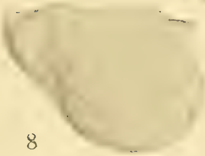
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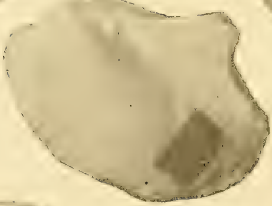
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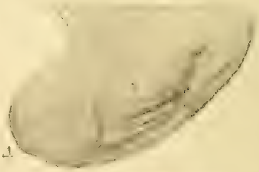
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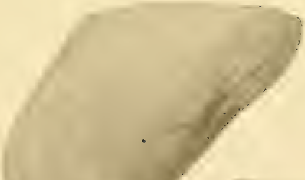
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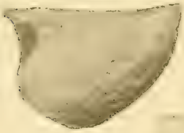
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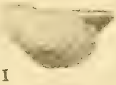
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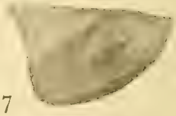
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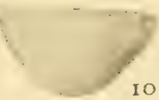
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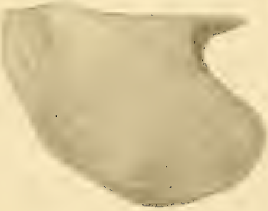
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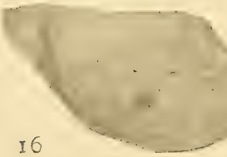
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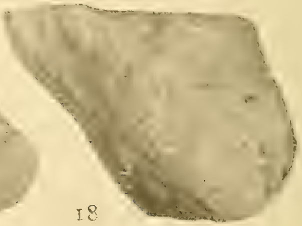
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## Explanation of Plate 22 (43)

FIGURE

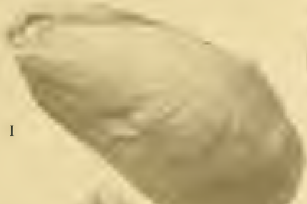
1. **Leptodesma mortoni** Hall. From the 'Chemung beds' at Little Genesee, N. Y. N. Y. S. Mus. spec. no 9337-4 P. 47.
2. Right valve of fig. 1.
3. Cardinal view of fig. 1.
4. **Leptodesma umbonatum** var. **depressum** Hall. Upper Chemung beds at Napoli Center, N. Y. N. Y. S. Mus. spec. no. 9356-1. P. 46.
5. Left valve of fig. 4.
6. **Leptodesma billingsi** Hall. From the 'Chemung beds' at Panama, N .Y. N. Y. S. Mus. spec. no. 9315-3. P. 47
7. **Leptodesma disparile** Hall. 'Upper Chemung beds' between Bradford, and Farmer's Valley, Pa. N. Y. S. Mus. spec. no. 9323-1.
8. **L. disparile** Hall. Same locality as fig. 7. N. Y. S. Mus. spec. no. 9323-3.
9. **L. disparile** Hall. Same locality as fig. 7. N. Y. S. Hus. spec .no. 9323-2.
10. **L. disparile** Hall. Same locality as fig. 7. N. Y. S. Mus. spec. no. 9323-4.
11. **L. disparile** Hall. Same locality as fig. 7. N. Y. S. Mus. spec. no. 9323-5.
12. **Leptodesma stephani** Hall. 'Upper Chemung beds' at Bradford, Pa. N Y. S. Mus. spec. no. 9354-3. P. 46.
13. **Leptodesma mentor** var. **maclurii** Hall. (**L. maclurii** Hall). From the 'Upper Chemung beds' at Smethport, Pa. N. Y. S. Mus. spec. No. 9333-1. P. 51.
14. **L. stephani** Hall. Same locality as fig. 12. N. Y. S. Mus. spec. no. 9354-1. P. 46.
15. **L. stephani** Hall. Same locality as fig. 12. N. Y. S. Mus. spec. no. 9354-2.
16. **Leptodesma curvatum** Hall. 'Upper Chemung beds' in McKean county, Pa. N. Y. S. Mus. spec. no. 9321-1. P. 47.
17. **Leptodesma becki** Hall ? . Chemung beds at Portville, N. Y. N. Y. S. Mus. spec. no. 9314-1. P. 45.
18. **Leptodesma mentor** var. **biton** Hall. (**L. biton** Hall). Upper Chemung beds south of Smethport, Pa. N. Y. S. Mus. spec. no. 9316-1. P. 50.

All illustrations natural size.

## EXPLANATION OF PLATE 23 (44)

FIGURE

1. **Modiola** cf. **metella** or **præcedens** Hall. Panama Conglomerate at Stone Ledge near Checkered School House, N. Y. Length 30 mm. P. 72.
2. **Leptodesma mentor** var. **sulcata** n. var. From a fine white quartzitic sandstone under the Olean conglomerate at 'Devil's Den' south of Smethport, Pa. Cardinal-line 45 mm. P. 51.
3. Cardinal view of fig. 1.
4. **Leptodesma mentor** var. **maxima** n. var. Same faunule as fig. 2. Distance from apex to base 57 mm. (See also plate 24). P. 51.
5. **Prorhynchus pæneplanus** n. sp. In the yellow conglomerate sandstone 100 feet above the road at Glade, Pa. Posterior height 40 mm. P. 61.
6. Right valve of fig. 1.
7. **Prorhynchus harrisi** n. sp. From the coarse light brown sandstone under the conglomerate at Stickley, Pa. Sub-Olean (?). Width along cardinal-line 47 mm. P. 60.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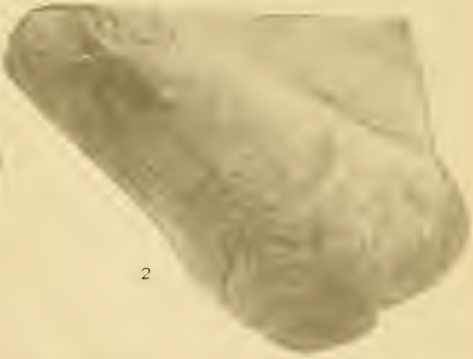
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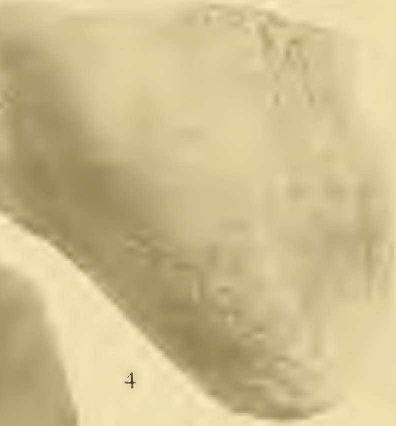
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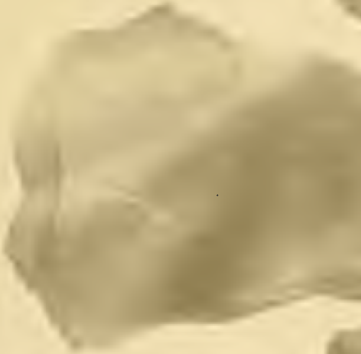
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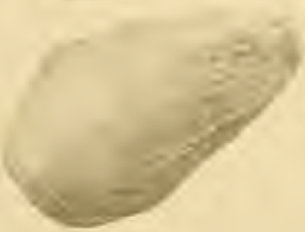
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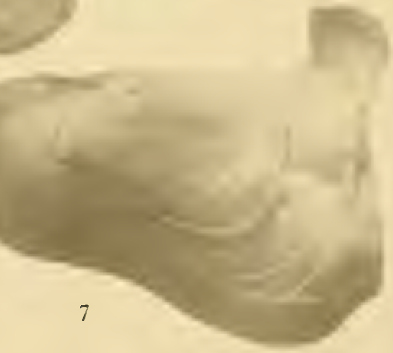
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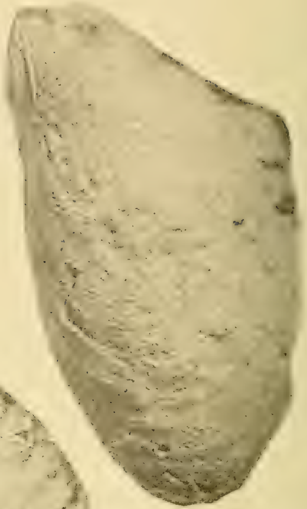
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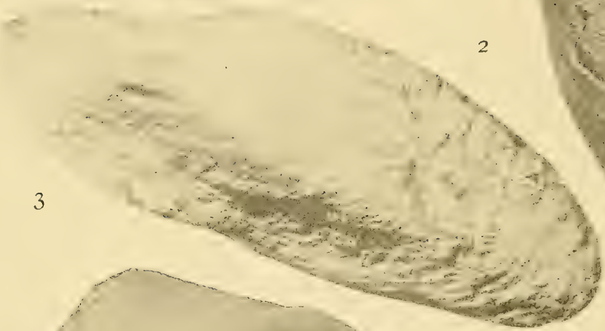
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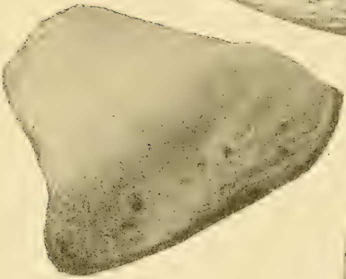
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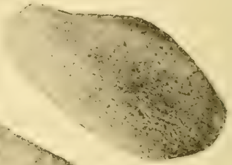
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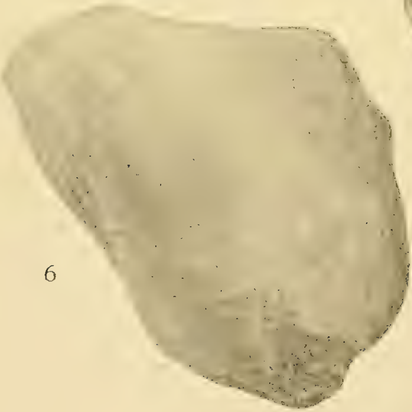
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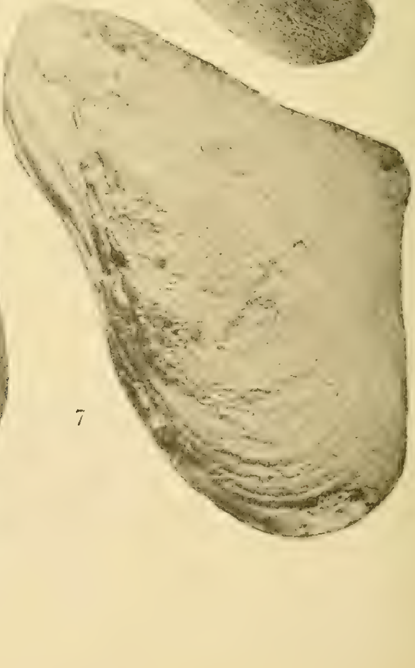
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## EXPLANATION OF PLATE 24 (45)

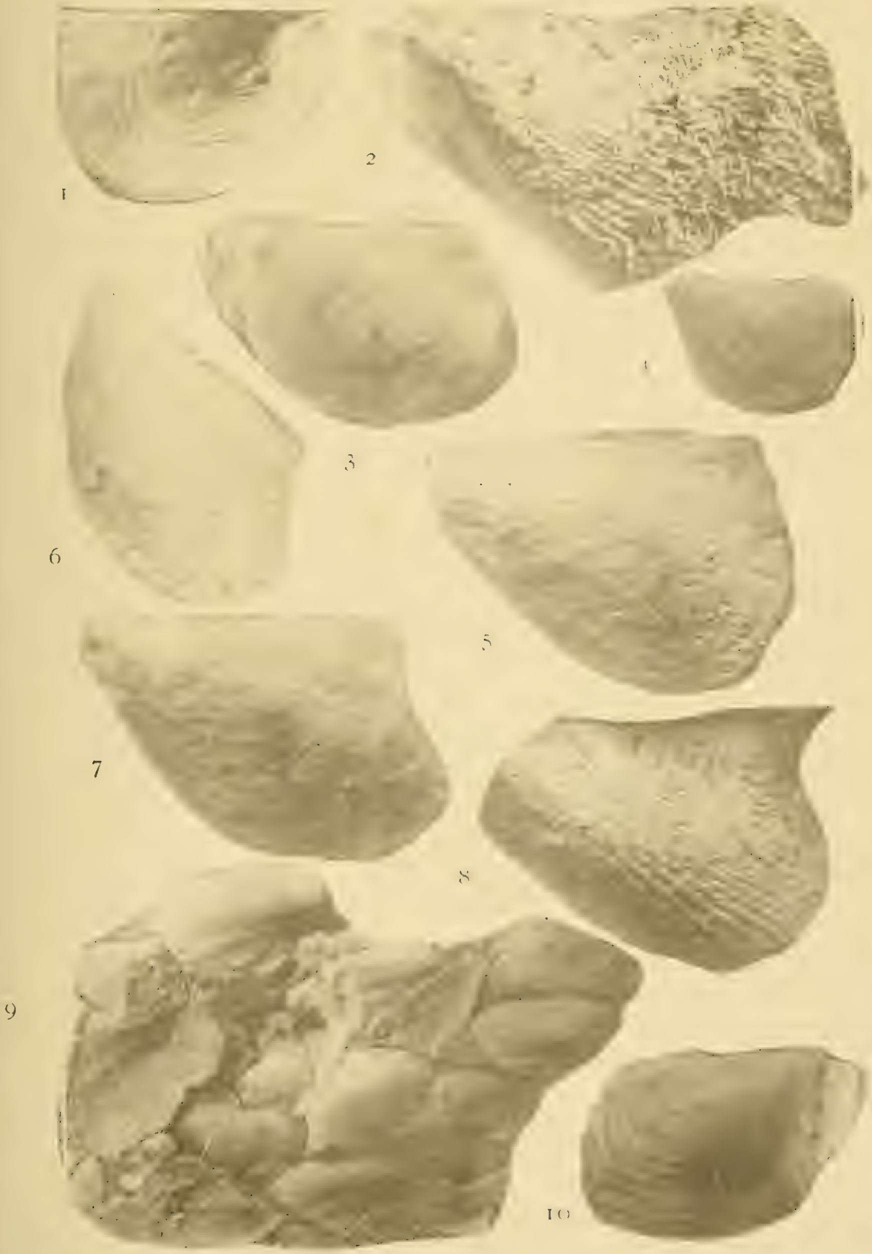
FIGURE

1. **Leptodesma mentor** var. **maxima n. var.** From the light gray sandstone under the Olean conglomerate at 'Devil's Den' south of Smethport, Pa. Hinge-line 32 mm. P. 53.
2. **Leptodesma mentor var. alpha** n. var. From the Oswayo beds in a road cut ½ mile from Mt. Jewett, Pa., on the road to Smethport, Pa. Hinge-line 30 mm. P. 53.
3. **Leptodesma carinifera** n. sp. Same faunule as fig. 2. Distance along the umbonal carina from the apex to the base 87 mm.
4. Right valve of fig. 1. P. 54.
5. **Leptodesma mentor** Hall. From a flat pebble conglomerate at Bradford, Pa. (Salamanca?). Hinge-line 12 mm. P. 49.
6. Left valve of fig. 1.
7. **Leptodesma mentor** var. **sulcata?** n. var. From the faunule of fig. 2. Hinge-line 47 mm. P. 51.

## EXPLANATION OF PLATE 25 (46)

FIGURE

1. **Leiopteria cornelli** n. sp. From the horizon of the Venango First Oil sand on Stone Hill near Stoneham, Pa. Hinge-line 30 mm. P. 56.
2. **Oleanella expansa.** From the Oswayo sandstone at Flat Iron Station near Olean Rock City, N. Y. Hinge-line 34 mm. P. 63.
3. **Leiopteria cornelli,** n. sp. From the same faunule as fig. 1. Hinge-line 28 mm. P. 56.
4. **Actinopteria** ? sp. From the Panama conglomerate at Stone ledge near Checkered School House near Panama, N. Y. Hinge-line 20 mm. P. 65.
5. **Actinopteria alpha,** n. sp. 10 feet above the Roosevelt highway on the northern out-skirts of Smethport, Pa. In a local, coarse, brown, micaceous sandstone. Hinge-line 20 mm. P. 64.
6. **Actinopteria alpha,** n. sp. From the same faunule as fig. 5. Hinge-line 37 mm.
7. **Idem.** Hinge-line 36 mm.
8. **Actinopteria beta,** n. sp. From the same faunule as fig. 5. Hinge-line of fragment 21 mm. P. 65.
9. **Ptychopteria sao** Hall. From the Panama conglomerate at Panama, N. Y. nat. size. P. 70.
10. **Leiopteria cornelli,** n. sp. Right valve of fig. 3. P. 56.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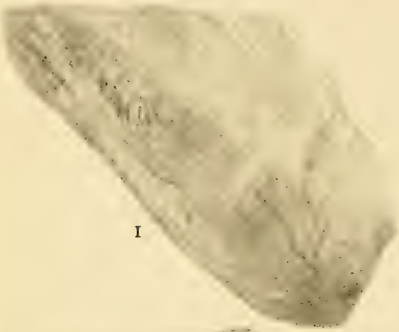
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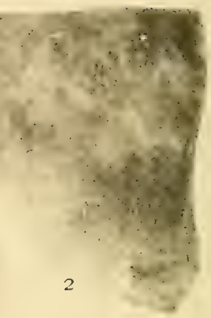
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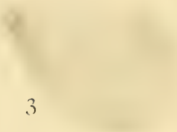
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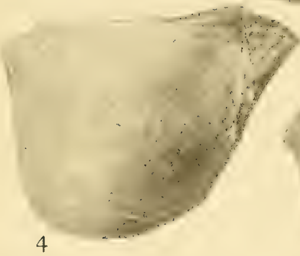
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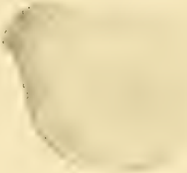
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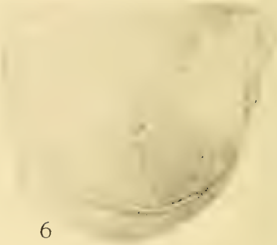
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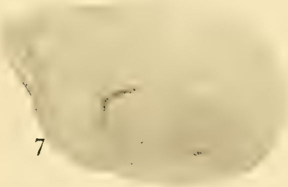
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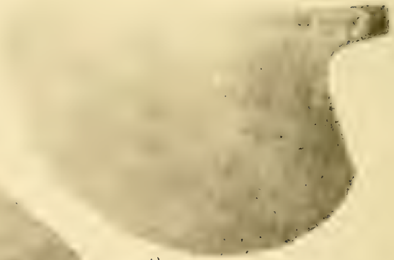
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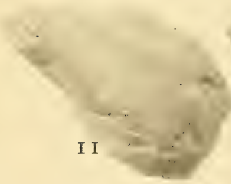
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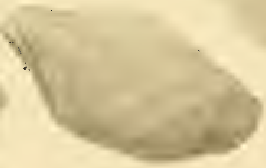
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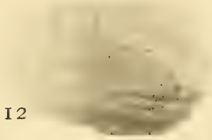
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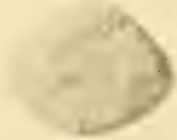
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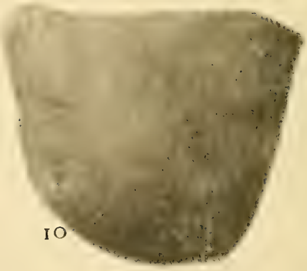
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## EXPLANATION OF PLATE 25a (46a)

FIGURE

1, 2. **Leptodesma** cf. **mentor,** var. **sulcata**, n. var. Oswayo sandstone near Olean, N. Y. Nat. size. P. 51.

3-10. **Pegasella ales,** n. gen. n. sp. Same faunule as figs. 1 , 2. Nat. size.

11. Immature form of fig. 1. P. 57.

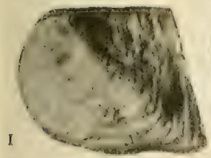
12. **Goniophora ruedemanni** n. sp. Same faunule as figs. 1-10. Nat. size P. 77.

13. Cross section of fig. 12.

## EXPLANATION OF PLATE 26 (47)

FIGURE

1. **Ptychopteria** cf. **trigonalis** Hall. From the Conewango formation below the Pope Hollow Conglomerate at Pope Hollow, N. Y. x5/4. P. 67.
2. **Ptychopteria spatulata** or **beecheri** Hall. From the Conewango formation at Glade, Pa. x 3-2. P. 69.
3. **Ptychopteria elongata** Hall. From the Chemung group at Panama, N. Y. P. 69.
4. **Ptychopteria spatulata** or **beecheri** Hall. Same faunule as fig. 2. Nat. size. P. 69.
5. **Ptychopteria spatulata** or **beecheri** Hall. Same faunule as fig. 2. x 3-2.
6. **Ptychopteria thetis** Hall ?. In the Conewango (?) 1mile west of Stoneham, Pa. x21-11. P. 70.
7. **Ptychopteria spatulata,** or **beecheri** Hall. Same faunule as fig. 2. x 13-11.
8. **Ptychopteria alata** Hall. From the faunule of fig. 1. x 5-4.
9. **Ptychopteria spatulata** or **beecheri** Hall. Faunule of fig. 2. x 14-9.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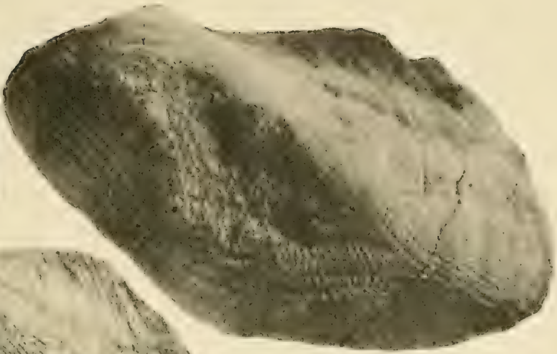
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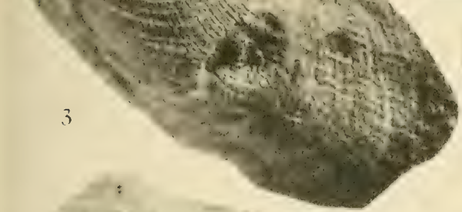
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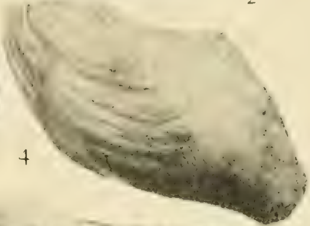
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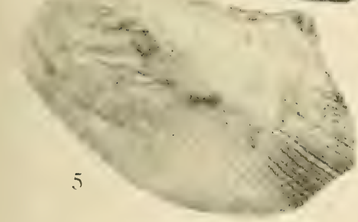
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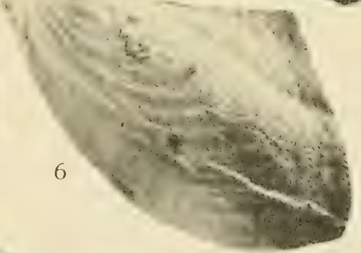
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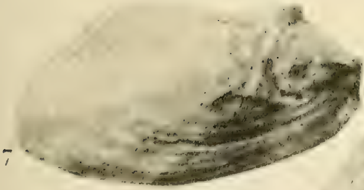
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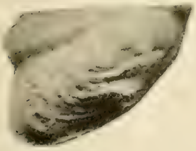
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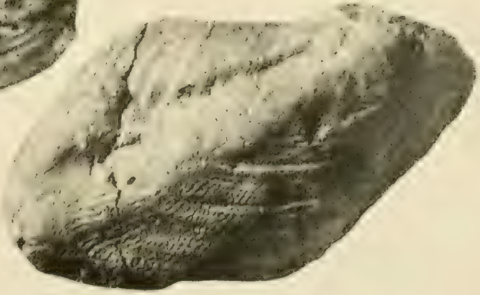
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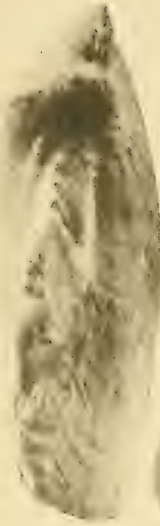

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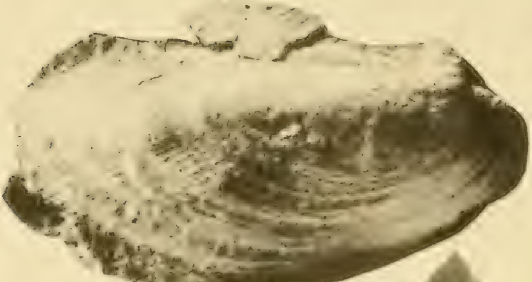

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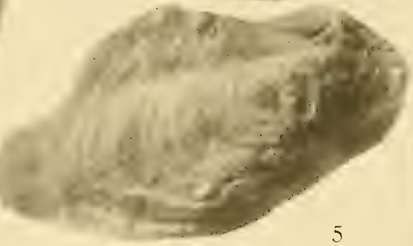

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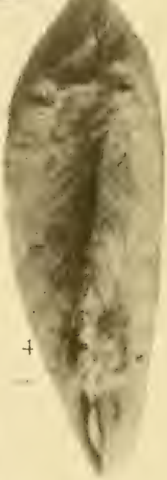

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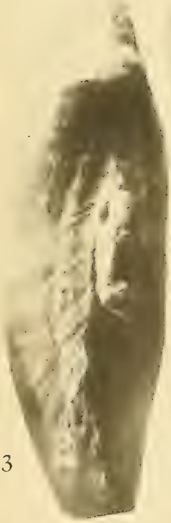

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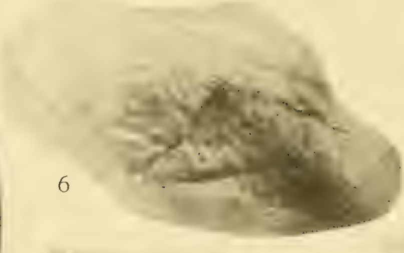

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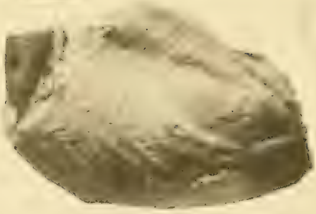

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## EXPLANATION OF PLATE 27 (48)

FIGURE

1-4. **Ptychopteria spatulata** or **beecheri** Hall. From the Conewango yellow standstone at Glade, Pa. approx. x 4-3.

5. **Ptychopteria elongata** Hall. The same faunule with fig. 1. x 17-6.

6. Left valve of fig. 5.

7. **Ptychopteria alata** Hall. From Conewango beds at Popes Hollow, N. Y. x 27-22.

8. **Ptychopteria alata** Hall. See fig. 7.

9. **Ptychopteria beecheri** Hall. From the yellow sandstone one mile east of Stoneham, Pa. x 5-2.

10. **Ptychopteria** cf. **trigonalis** Hall. Same faunule as fig. 7. x 33-18.

## EXPLANATION OF PLATE 28 (49)

FIGURE

1. **Ptychopteria proto** Hall. From 'Chemung beds' at Smethport, Pa. N. Y. S. Mus. spec. no. 9805-1.
2. **Ptychopteria sinuosa** Hall. From 'Chemung beds' at Smethport, Pa. N. Y. S. Mus. spec. no. 9808-1.
3. **Ptychopteria eudora** Hall. 'Chemung ? beds' at Panama, N. Y. N. Y. S. Mus. spec. no. 9803-1.
4. **Ptychopteria thetis** Hall. Chemung ? beds at Panama, N. Y. N. Y. S. Mus. spec. no. 9810-4.
5. **Ptychopteria proto** Hall. 'Chemung beds' at Smethport, Pa. N. Y. S. Mus. spec. no. 9805-1.
6. **P. proto** Hall. Same locality as fig. 5. N. Y. S. Mus. spec. no. 9805-2.
7. **P. thetis** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9810-3.
8. **P. thetis** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9810-2.
9. **Ptychopteria trigonalis** Hall. Same locality as fig. 5. N. Y. S. Mus. spec. no. 9811-1. P. 67.
10. **P. trigonalis** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9811-2.
11. **Ptychopteria alata** Hall. 'Chemung beds?' at Salamanca, N. Y. N. Y. S. Mus. spec. no. 9800-1. P. 68.
12. **P. alata** Hall. Same locality as fig. 11. N. Y. S. Mus. spec. no. 9800-2.
13. **P. alata** Hall. Same locality as fig. 11. N. Y. Mus. spec. no. 9800-3.
14. **P. alata** Hall. Same locality as fig. 11. N. Y. S. Mus. spec. no. 9800-4.
15. **P. alata** Hall. Same locality as fig. 11. N. Y. S. Mus. Spec. no. 9800-5.
16. **P. thetis** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9810-1.
17. **Oleanella expansa** (Hall). N. G. (**Ptychopteria expansa** Hall). Same locality as fig. 5. N. Y. S. Mus. spec. no. 9805-1. P. 63.
18. **Ptychopteria spio** Hall. Same locality as fig. 4. N. Y. S. Mus. spec. no. 9809-1. P. 70.

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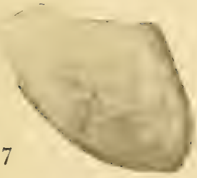
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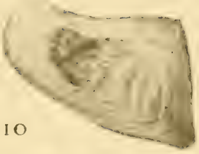
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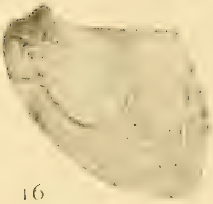
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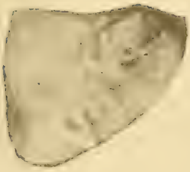
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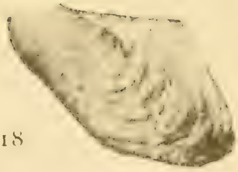
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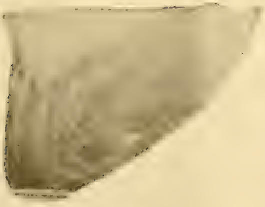
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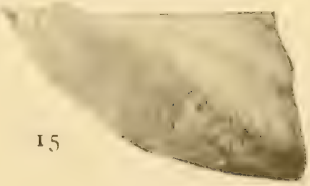
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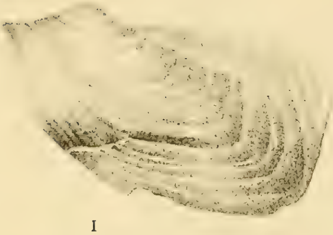
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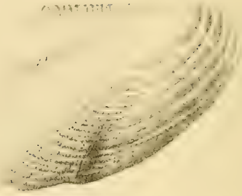
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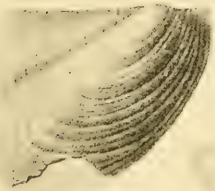
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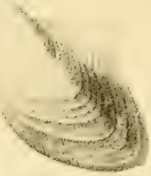
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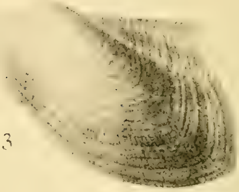
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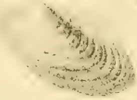
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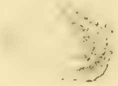
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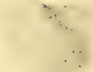
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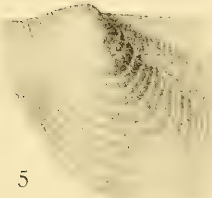
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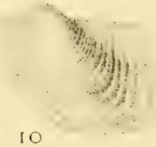
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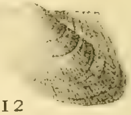
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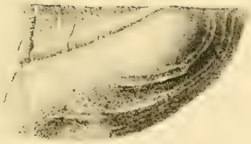
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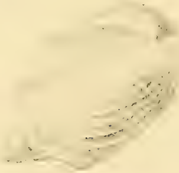
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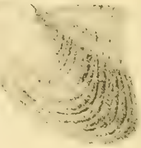
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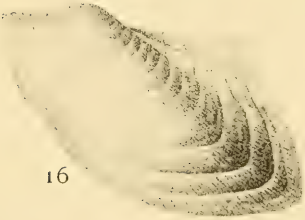
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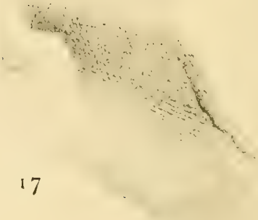
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## EXPLANATION OF PLATE 29 (50)

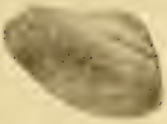
FIGURE

1. **Ptychopteria spatulata** Hall. From Pal. of N. Y., v, i, pl. 85, fig. 20. P. 69.
2. **Ptychopteria lata** Hall. Ibid. fig. 25.
3. **Ptychopteria lata** Hall. Ibid. fig. 23.
4. **Ptychopteria perlata** Hall. Ibid. fig. 38. P. 68.
5. **Ptychopteria perlata** Hall. Ibid. fig. 39.
6. **Ptychopteria falcata** Hall. Ibid. fig. 6. P. 68.
7. **Ptychopteria falcata** Hall. Ibid. fig. 7.
8. **Ptychopteria gibbosa** Hall. Ibid. fig. 5. P. 67.
9. **Ptychopteria lobata** Hall. Ibid. fig. 37. P. 67.
10. **Ptychopteria thalia** Hall. Ibid. fig. 33. P. 68.
11. **Ptychopteria thalia** Hall. Ibid. fig. 32.
12. **Ptychopteria galene** Hall. Ibid. fig. 30. P. 68.
13. **Ptychopteria galene** Hall. Ibid. fig. 31.
14. **Ptychopteria galene** Hall. Ibid. fig. 39.
15. **Ptychopteria beecheri** Hall. Ibid. fig. 22. P. 69.
16. **Ptychopteria beecheri** Hall. Ibid. fig. 21.
17. **Ptychopteria vanuxemi** Hall. Ibid. fig. 36. P. 67.

## EXPLANATION OF PLATE 30 (51)

FIGURE

1. **Ptychopteria sao** Hall. From the 'Chemung'? beds at Panama, N. Y., N. Y. Mus., spec. no. 9807-6. P. 70.
2. **P. sao** Hall. Same locality as fig. 1. N. Y. mus., spec. no. 9807-1.
3. **P. sao** Hall. Same locality as fig. 1. N. Y S. Mus., spec. no. 9807-7.
4. **P. sao** Hall. Same locality as fig. 1. N. Y. S. Mus., spec. no. 9807-5.
5. **P. sao** Hall. Same locality as fig. 1. N. Y. S. Mus., spec. no. 9807-3.
6. **P. sao** Hall. Same locality as fig. 1. N. Y. S. Mus., spec. no. 9807-2.
7. **Ptychopteria elongata** Hall. From the same locality as fig. 1. N. Y. S. Mus., spec. no. 9801-1. P. 69.
8. **P. elongata** Hall. Same locality as fig. 1. N. Y. S. Mus., spec. no. 9801-3.
9. **P. elongata** Hall. Same locality as fig. 1. N. Y. S. Mus, spec. no. 9801-2.
10. **Ptychopteria eucrate** Hall. Same locality as fig. 1. N. Y. S. Mus., spec. no. 9802-1. P. 69.
11. **P. eucrate** Hall. From the same locality as fig. 1. N. Y. S. Mus., spec. no. 9802-3.
12. **P. eucrate** Hall. On slab of rock with type specimen no. 9802-3.
13. **P. eucrate** Hall. Same locality as fig. 1. N. Y. S. Mus., spec. no. 9802-2.
14. **Ptychopteria salamanca** Hall. From 'Chemung beds' at rock city near Salamanca, N. Y. N. Y. S. Mus., spec. no. 9806-2. P. 67.
15. **P. salamanca** Hall. Same locality as fig. 14. N. Y. S. Mus., spec. no. 9806-3.
16. **P. salamanca** Hall. Same locality as fig. 14. N. Y. S. Mus., spec. no. 9806-1.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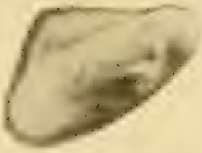
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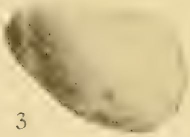
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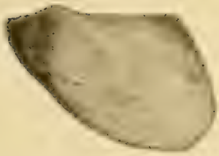
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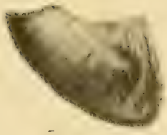
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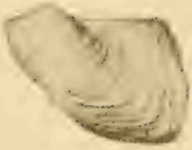
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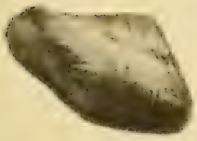

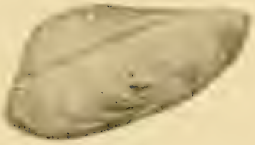
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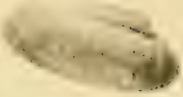
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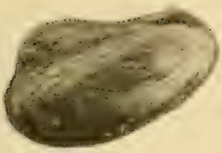
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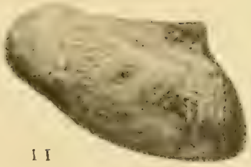
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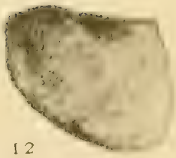
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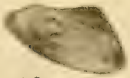
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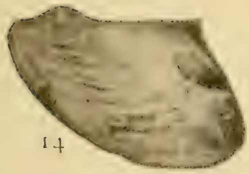
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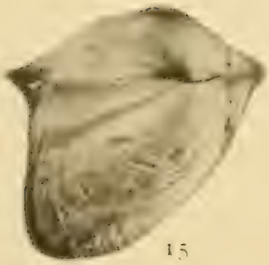
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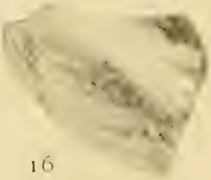
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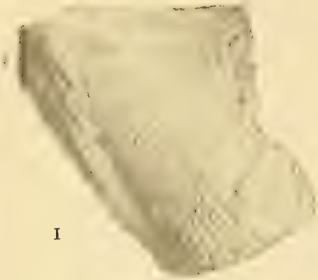
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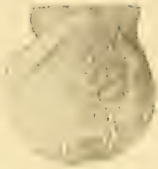
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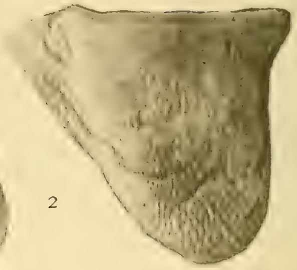
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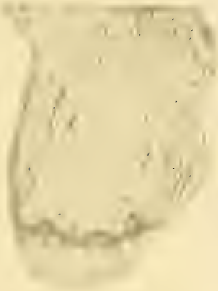
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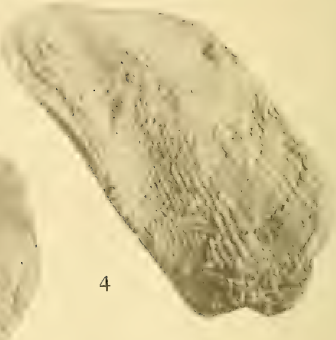
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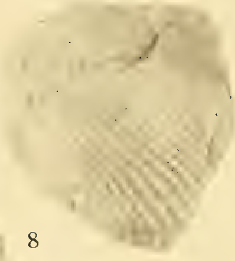
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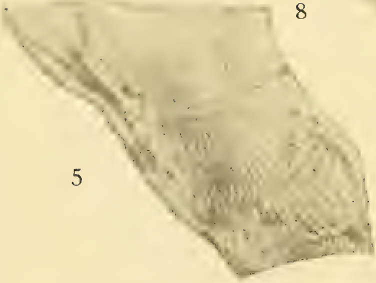
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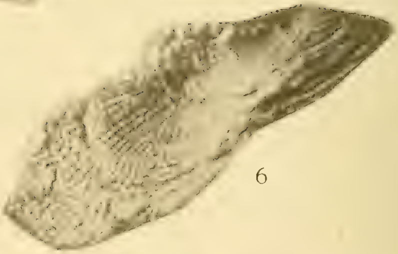
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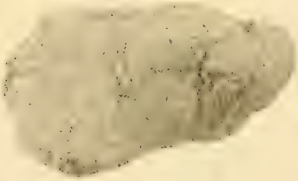
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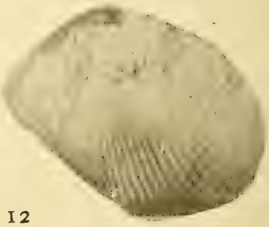
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## EXPLANATION OF PLATE 30a (51a)

FIGURE

1-7. **Oleanella expansa** (Hall), n. gen. Oswayo sandstone near Olean, N. Y. Nat. size. P. 69.

8. **Oleanella expansa,** var. **gamma** n. var. Same faunule as figs. 1-7. Nat-size. P. 69.

9. **Aviculipecten** sp. Same faunule as fig. 9. Nat. size.

10. **Aviculipecten** sp. Same faunule as fig. 9 nat. size.

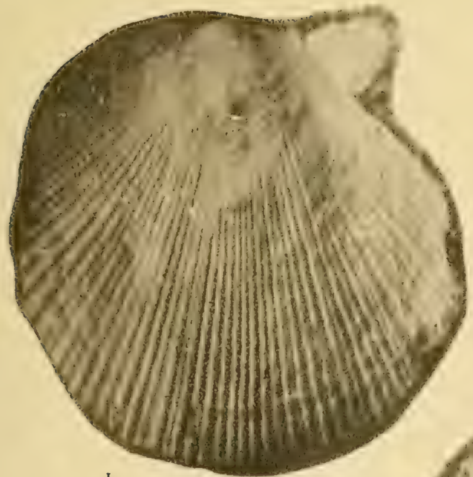
11. **Nucula sp.** Same faunule as figs. 1-10. x 2.

12. **Pararca** sp. undet. Nat. size.

## EXPLANATION OF PLATE 31 (52)

FIGURE

1. **Aviculipecten æquilateralis** Hall. Conewanga beds 2 miles northwest of Warren, Pa. Height 53 mm. P. 41.
2. **Aviculipecten** cf. **striatus** (Hall). From the brown quartzitic sandstone below the conglomerate at Stickley, Pa. Height 17 mm. P. 40.
3. **A.** cf. **striatus** (Hall). From the faunule of fig. 2. Height 21 mm.
4. **A.** cf. **striatus** (Hall). From the figure of fig. 1. Height 25 mm.
5. **A.** cf. **striatus** (Hall). From the faunule of fig. 1. Height 24 mm.
6. **Aviculipecten** sp. An external cast. Conewanga formation near Bradford, Pa. Height 38 mm.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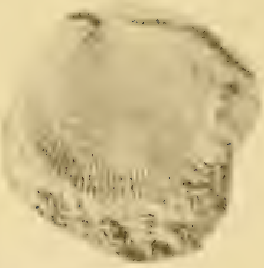
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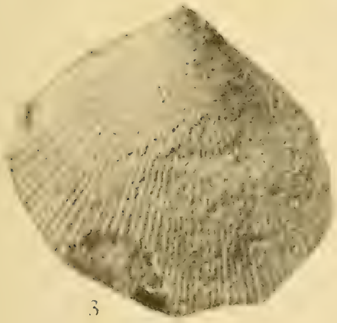
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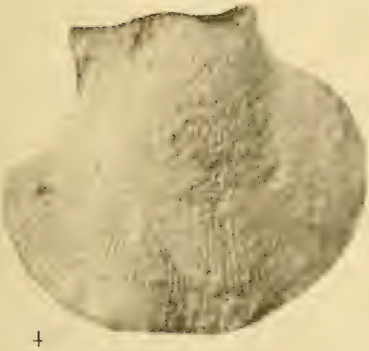
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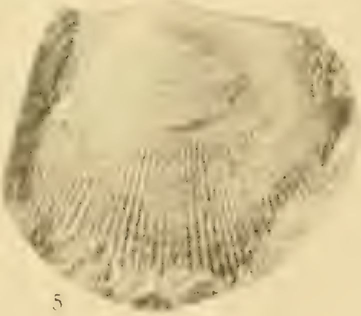
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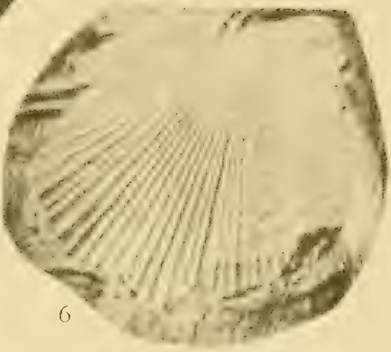
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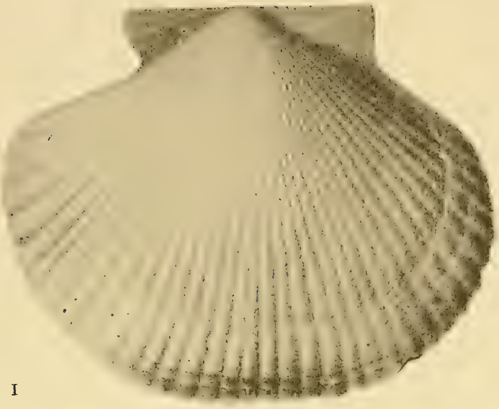
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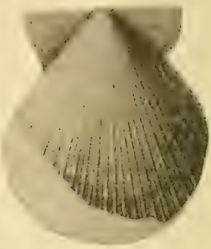
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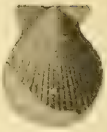
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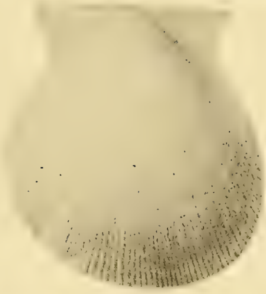
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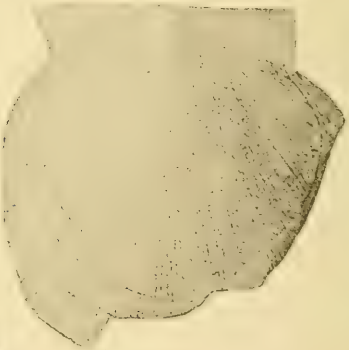
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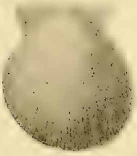
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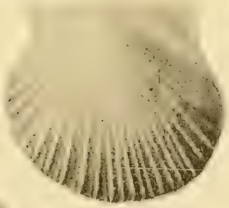
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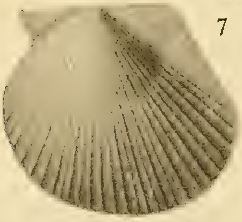
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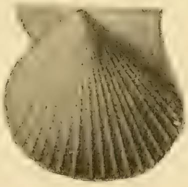
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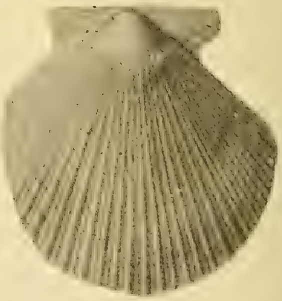
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## EXPLANATION OF PLATE 32 (53)

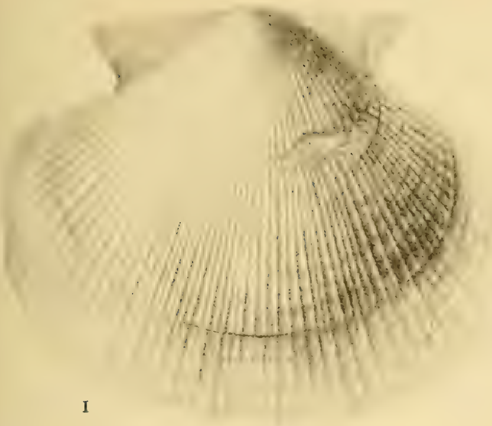
FIGURE

1. **Aviculipecten ellipticus** Hall. From Pal. of N. Y., v, i, pl. 7, fig. 31. P. 40.
2. **Aviculipecten celsus** Hall. Ibid. fig. 30. P. 40.
3. **A. celsus** Hall. Ibid. fig. 29.
4. **Aviculipecten striata** Hall. Pal. of N. Y., v, i, pl. 10, fig. 4. P. 40.
5. **Aviculipecten æquilata** Simpson. From Tr. Am. Phil. Soc., n. s. 16, 1889, p. 445. P. 41.
6. **A. striata** Hall. Pal. of N. Y., v, i, pl. 10, fig. 3.
7. **Aviculipecten tenuis** Hall. Pal. of N. Y., v, i, pl. 81, fig. 6. P. 40.
8. **A. tenuis** Hall. Ibid., pl. 7, fig. 28.
9. **A. tenuis** Hall. Ibid. fig. 27.
10. **Aviculipecten æquilateralis** Hall. Ibid. pl. 82, fig. 1. P. 41.

## EXPLANATION OF PLATE 33 (54)

FIGURE

1. **Aviculipecten patulus** Hall. From Pal. of N. Y., pl. 7, fig. 33. P. 41.
2. **A. patulus** Hall. **Ibid**, fig. 32.
3. **Aviculipecten cancellatus** Hall. **Ibid,** fig. 17. P. 41.
4. **A. cancellatus** Hall. **Ibid.** fig. 12.
5. **A. cancellatus** Hall. **Ibid.** fig. 15. 15.
6. **Aviculipecten duplicatus** Hall. **Ibid.,** fig. 3. P. 40.
7. **A. duplicatus** Hall. **Ibid.,** fig. 7.
8. **A duplicatus** Hall. **Ibid.,** fig. 2.
9. **A duplicatus** Hall. **Ibid.,** fig. 6.
10. **A. duplicatus** Hall. **Ibid.** fig. 4.
11. **Lyriopecten solox** Hall. **Ibid.,** pl. 24, fig. 5. P. 41.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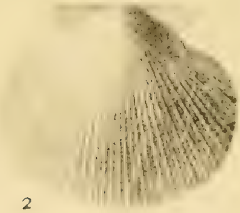
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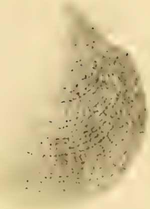
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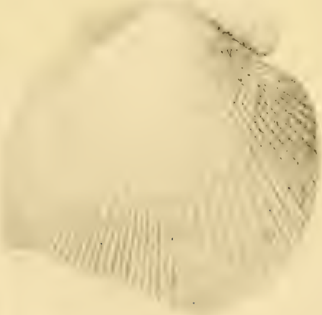
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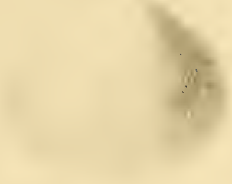
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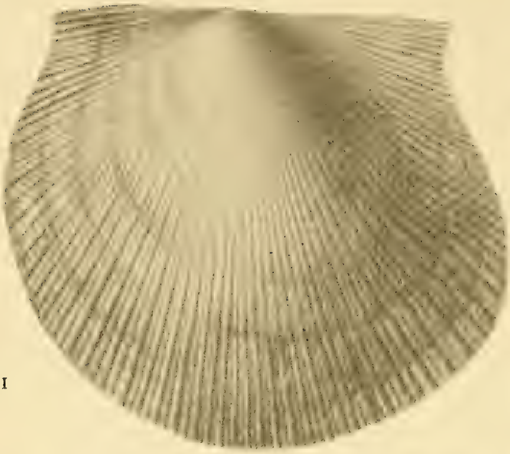

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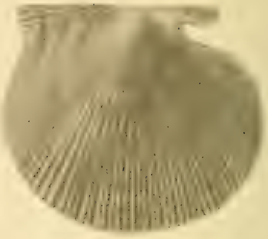

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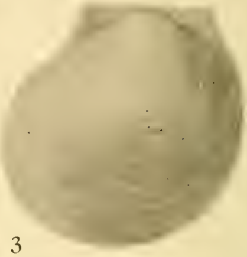

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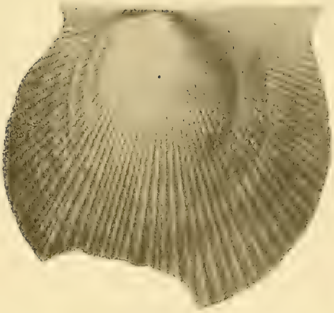

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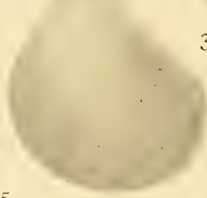

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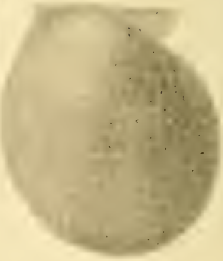

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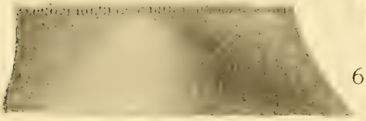

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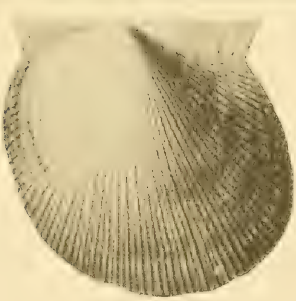

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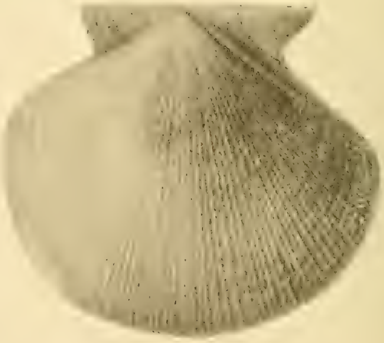

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## Explanation of Plate 34 (55)

FIGURE

1. **Pterinopecten suborbicularis** Hall. From Pal. of N. Y., v, i, pl. 24, fig. 10. P. 41.
2. **P. suborbicularis** Hall. **Ibid.**, pl. 82, fig. 4.
3. **Crenipecten crenulatus** Hall. **Ibid.** pl. 9, fig. 6. P. 42.
4. **Pterinopecten suborbicularis** Hall. **Ibid.** pl. 8, fig. 2.
5. **Crenipecten impolitus** Hall. **Ibid.** pl. 9, fig. 14. P. 42.
6. **Crenipecten micropterus** Hall. **Ibid.** fig. 23. P. 42.
7. **Crenipecten amplus** Hall. **Ibid.** fig. 9. P. 42.
8. **Crenipecten crenulatus** Hall. **Ibid.** fig. 17.
9. **Pterinopecten suborbicularis** Hall. **Ibid.** pl. 8, fig. 1. P. 41.
10. **Crenipecten winchelli** Hall. **Ibid.** pl. 9, fig. 27. P. 42.

## EXPLANATION OF PLATE 35 (56)

FIGURE

1. **Lyriopecten fasciata** Hall. From Pal. of N. Y., v, i, pl. 9, fig. 11. P. 41.
2. **Lyriopecten priamus** Hall. **Ibid.** pl. 82, fig. 6. P. 41.
3. **Lyriopecten fasciata** Hall. **Ibid.**, pl. 9, fig. 10. P. 41.
4. **Crenipecten leon** Hall. **Ibid.**, fig. 12. P. 42.
5. **C. leon** Hall. **Ibid.** pl. 83, fig. 8.
6. **Lyriopecten alternatus** Simpson. Tr. Am. Phil. Soc. n. s. 16, 1889, p. 446. P. 41.
7. **Crenipecten liratus** Hall. Pal. of N. Y., v, i, pl. 9, fig. 24. P. 42.
8. **C. liratus** Hall. **Ibid.**, pl. 83, fig. 9.

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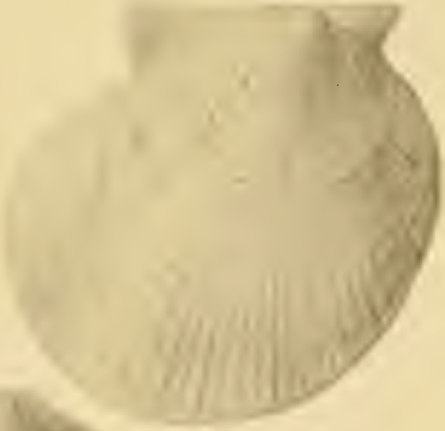

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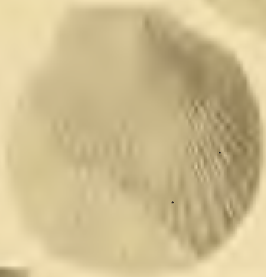

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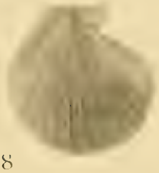

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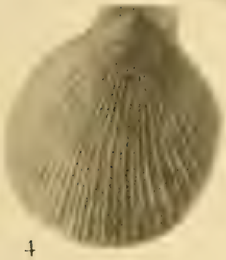

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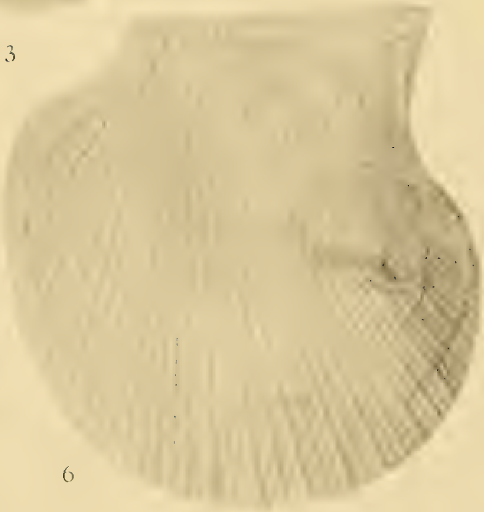

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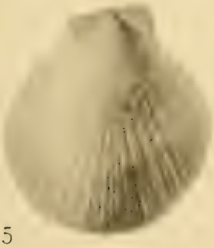

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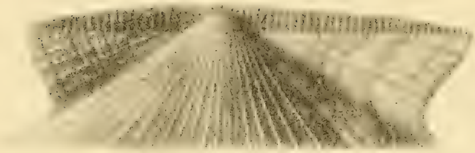

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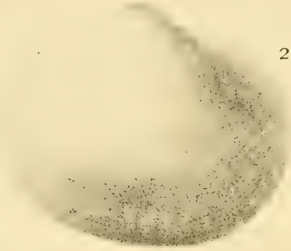

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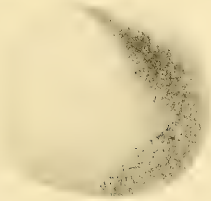

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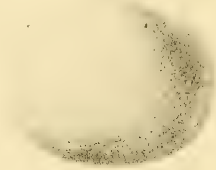

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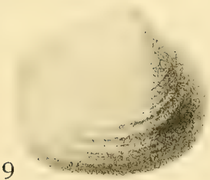

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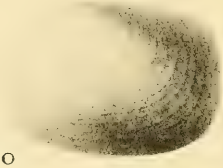

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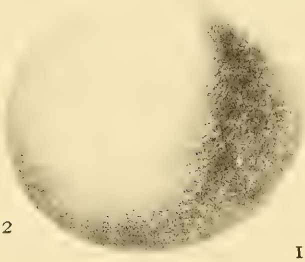

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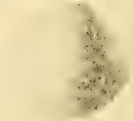

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## EXPLANATION OF PLATE 36 (57)

FIGURE

1. **Crenipecten winchelli** Hall. From Pal. of N. Y., v. i, pl. 9, fig. 28. P. 42.
2. **C. winchelli** Hall. **Ibid.** fig. 25.
3. **C. winchelli** Hall. **Ibid.** fig. 29.
4. **Edmondia phillipi** Hall. Pal. N. Y., v, i, pl. 64, fig. 17. P. 79.
5. **E. phillipi** Hall. **Ibid.,** fig. 12.
6. **E. phillipi** Hall. **Ibid.,** fig. 11.
7. **E. phillipi** Hall. **Ibid.,** fig. 14.
8. **E. phillipi** Hall. **Ibid.,** fig. 9.
9. **Edmondia rhomboidea** Hall. **Ibid.,** fig. 8. P. 79.
10. **Edmondia transversa** Hall. **Ibid.,** fig. 24. P. 79.
11. **Edmondia ? subcarinata** Hall. **Ibid.,** pl. 64, fig. 31. P. 79.
12. **Paracyclas ignota** Hall. **Ibid.,** pl. 72, fig. 34. P. 84.
13. **Paracyclas pauper** Hall. **Ibid.,** pl. 75, fig. 25. P. 85.
14. **P. pauper** Hall. **Ibid.,** fig. 24.
15. **P. pauper** Hall. **Ibid.,** fig. 26.
16. **Nucula globularis** Hall. **Ibid.** pl. 93, fig. 6. P. 74.

## EXPLANATION OF PLATE 37 (58)

FIGURE

1. **Pararca sao** Hall. From Pal. of N. Y., v, i, pl. 70, fig. 17. P. 81.
2. **Pararca venusta** Hall. **Ibid.**, pl. 94, fig. 22. P. 80.
3. **Ptychopteria ? obsoleta** Simpson. Tr. Am. Phil. Soc., n. s. 16., 1889, p. 448. P. 70.
4. **Prorhynchus nasutum** Hall. From Pal. of N. Y., pl. 96, fig. 6. P. 62.
5. **Pararca neglecta** Hall. **Ibid.**, pl. 70, fig. 13. P. 80.
6. **Prorhynchus angulatum** Hall. **Ibid.**, pl. 96, fig. 7. P. 60.
7. **Prorhynchus quadratum** Hall. **Ibid.**, pl. 79, fig. 49. P. 59.
8. **P. quadratum** Hall. **Ibid.**, fig. 42.
9. **P. quadratum** Hall. pl. 96, fig. 5.
10. **P. quadratum** Hall. pl. 79, fig. 43.
11. **P. quadratum** Hall. **Ibid.**, fig. 45.
12. **P. quadratum** Hall. **Ibid.**, fig. 48.
13. **P. quadratum** Hall. **Ibid.**, fig. 47.
14. **Leptodesma parallellum** Simpson. Tr. Am. Phil. Soc., n. s. 16, 1889. p. 448. P. 55.

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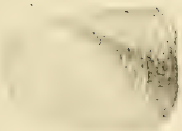

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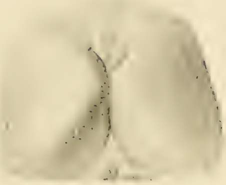

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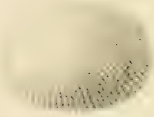

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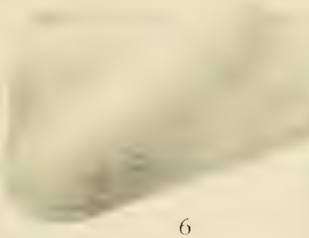

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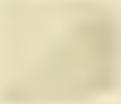

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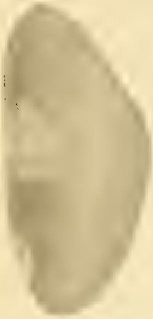
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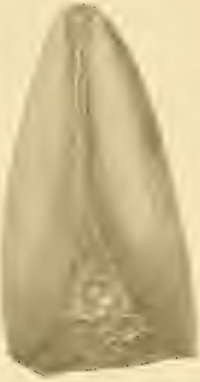
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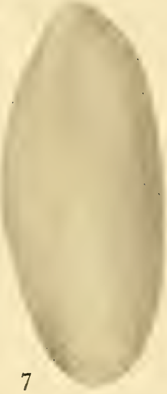
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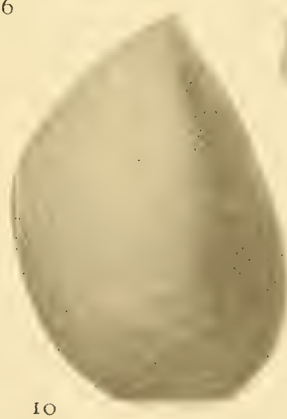
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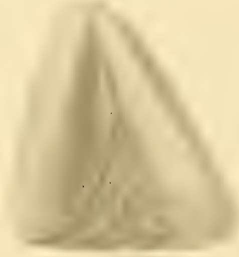
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## EXPLANATION OF PLATE 38 (59)

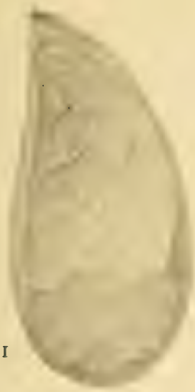
FIGURE

1. **Modiola (Mytilops) præcedens** Hall. From Pal. of N. Y., v, i, pl. 38, fig. 13, P. 72.
2. **M. præcedens** Hall. **Ibid.**, fig. 11.
3. **M. præcedens** Hall. **Ibid.**, fig. 14.
4. **M. præcedens** Hall. **Ibid.**, fig. 17.
5. **M. præcedens** Hall. **Ibid.**, fig. 18.
6. **Mytilarca simplex** Hall. **Ibid.**, pl. 33, fig. 21; P. 22.
7. **Modiola (Mytilops) metella** Hall. **Ibid.**, pl. 87, fig. 9; P. 72.
8. **Mytilarea simplex** Hall. **Ibid.** pl. 33, fig. 11. P. 72.
9. **Modiola (Mytilops) metella** Hall. **Ibid.**, pl. 33, fig. 24.
10. **Mytilarca lata** Hall. **Ibid.**, pl. 33, fig. 22; P. 72.
11. **Modiola (Mytilops) præcedens** Hall. **Ibid.**, pl. 33, fig. 16. P. 72.
12. **M. præcedens** Hall. **Ibid.**, fig. 10.
13. **Mytilarca regularis** Hall. **Ibid.**, pl. 32, fig. 12. P. 71.

## EXPLANATION OF PLATE 39 (60)

FIGURE

1. **Mytilarca chemungensis** Hall. From the Pal. of N. Y., v, i, pl. 32, fig. 13. P. 71.
2. **M. chemungensis** Hall. **Ibid.**, fig. 9.
3. **M. chemungensis** Hall. **Ibid.**, fig. 8.
4. **Mytilarca gibbosa** Hall, **Ibid.**, pl. 87, fig. 20. P. 72.
5. **M. gibbosa** Hall. **Ibid.**, fig. 7.
6. **Mytilarca occidentalis** Hall. **Ibid.**, pl. 33, fig. 3. P. 72.
7. **M. occidentalis** Hall. **Ibid.**, fig. 4.
8. **M. occidentalis** Hall. **Ibid.**, fig. 5.
9. **Phthonia truncata** Hall. **Ibid.**, pl. 94, fig. 4. P. 87
10. **Phthonia nitida** Hall. **Ibid.**, fig. 5. P. 87.
11. **P. nitida** Hall. **Ibid.**, fig. 6.
12. **Prothyris exuta** Hall. **Ibid.**, pl. 94, fig. 9. P. 86.
13. **Cypricardinia consimilis** Hall. **Ibid.**, pl. 79, fig. 8. P. 87.
14. **C. consimilis** Hall. **Ibid.**, fig. 19.
15. **Paleoneilo elongata** Hall. **Ibid.**, pl. 48, fig. 39. P. 74.
16. **P. elongata** Hall. **Ibid.**, pl. 93, fig. 11a.
17. **Paleanatina solenoides** Hall. **Ibid.**, pl. 79, fig. 38. P. 88.
18. **P. solenoides** Hall., **Ibid.**, fig. 39.
19. **Paleanatina sinuata** Hall. **Ibid.**, pl. 96, fig. 4. P. 88.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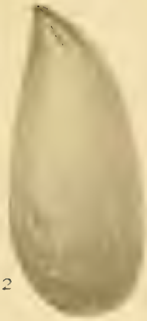
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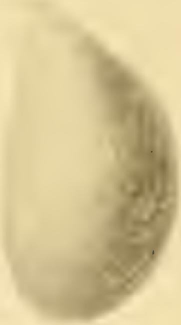
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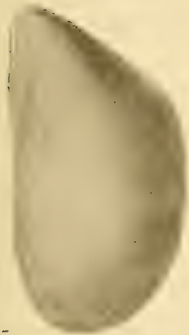
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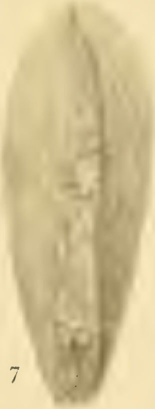
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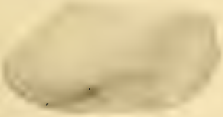
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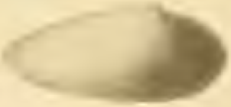
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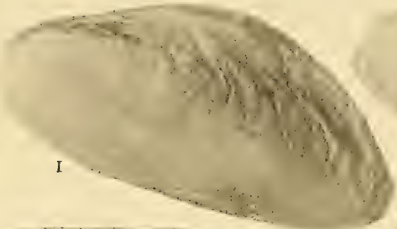
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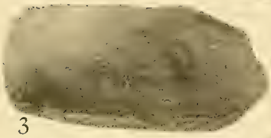
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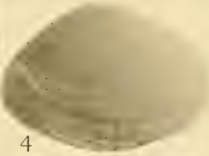
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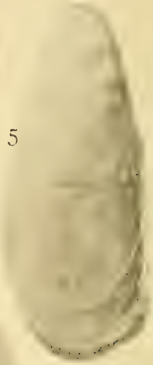
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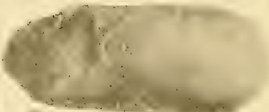
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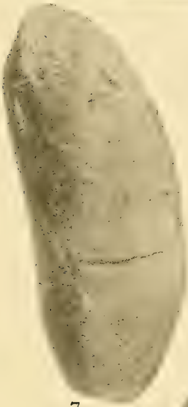
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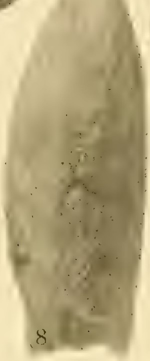
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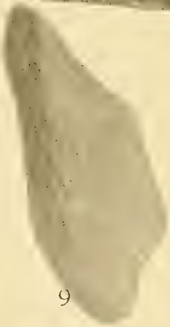
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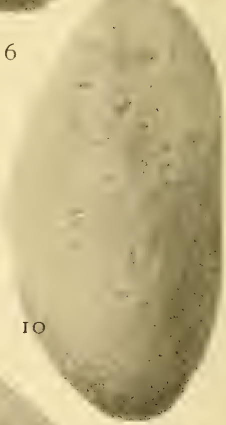
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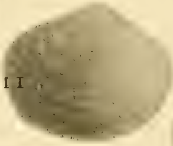
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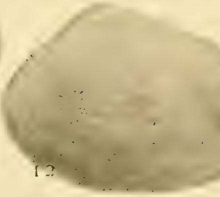
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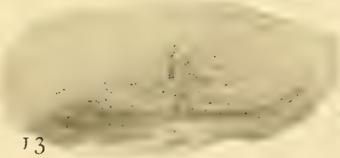
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## EXPLANATION OF PLATE 40 (61)

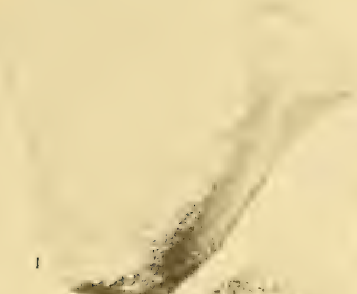
FIGURE

1. **Modiola metella** Hall. From a light brown conglomeritic sandstone at Bradford, Pa. Hinge-line approx. 30 mm. P. 73
2. **Paleanatina, cf. typa** Hall. From the faunule with fig. 1. Greatest length 29 mm. P. 87.
3. The right valve of fig. 2.
4. **Nucula cf. globularis** Hall. From a calcareous sandstone in a creek bed one mile east of Stoneham, Pa. Above the 'Sub Olean' conglomerate. Height 14 mm. P. 74.
5. **Mytilarca, cf. occidentalis** Hall. Conewango formation 2 miles north west of Warren, Pa. Total length 34 mm. P. 72.
6. **Paleanatina, cf. typa** Hall. From the faunule with fig. 1, length 30 mm. P. 87.
7. **Modiola præcedens** Hall. From the faunule with fig. 1. Total length 47 mm. P. 72.
8. The right valve of fig. 7.
9. **Leptodesma mytiliforme** Hall. 10 feet above the Roosevelt highway on the north boundary of Smethport, Pa. In a coarse conglomeritic local sandstone. Hinge-line 13.5 mm. P. 43.
10. Right valve of fig. 1.
11. **Nucula** cf. **globularis** Hall. From the Conewango. Height 14 mm. P. 74. Height 14 mm. P. 74.
12. **Paleoneilo, sp.** Upper Conewango at Bradford, Pa. x 19/6.
13. **Paleanatina, cf. typa** Hall. From the faunule of fig. 1. Hinge-line 16 mm.
14. Left valve of fig. 13.
15. **Cardinal** view of fig. 13.
16. **Prorhynchus quadratus** Hall. From a light brown quartzitic sandstone 100 feet above the road at Glade, Pa. Height 14 mm. P. 59.
17. **Modiola, sp.** From the faunule of fig. 11. Length 37mm. P. 72.

## EXPLANATION OF PLATE 41 (62)

FIGURE

1. **Leptodesma ruedemanni,** n. sp. From a fine grayish sandstone just below the Olean conglomerate at 'Devils Den' south of Smethport, Pa. Nat. size. P. 54.
2. **Leptodesma stephani** Hall. From the upper Chemung beds near Bradford, Pa. Cardinal length 35 mm. P. 46.
3. **Leptodesma potens** Hall. From the Chemung rocks at Panama, N. Y. Hinge-line 33 mm. P. 45.
4. **Edmondia,** sp. From the Salamanca conglomerate at Salamanca Rock city, north of Salamanca, N. Y. Height 18 mm. P. 79.
5. **Schizodus,** sp. In a light brown sandstone 100 feet above the road at Glade, Pa. Height 24 mm.
6. **Nucula,** sp. From the same faunule as fig. 5. Length 28 mm.
7. **Leptodesma stephani** Hall. From the Conewango beds one mile east of Stoneham, Pa. Length 32 mm. P. 46.
8. **Paleanatina,** sp. (?) From the faunule of fig. 4. Length 23 mm.
9. **Grammysia,** sp. Impressions of an external cast. From the Conewango beds at Gowanda, N. Y. Length 22 mm.
10. **Paleanatina angusta** Hall. From a coarse white conglomerate at Portville, N. Y. Length 29 mm. P. 88.
11. **Paleanatina typa** Hall. From the faunule of fig. 10. Length 19 mm., P. 88.
12. **Leptodesma mentor,** var. **maxima** (?) n. var. From the faunule of fig. 1. Hinge-line 38 mm. P. 53.
13. **Anomia** (?) **Archinacella** (?) **incerta** n. sp. From the base of the Conewango formation at Stone Hill near Stoneham, Pa. Height approx. 25 mm. P. 92.
14. **Mytilarca gibbosa** Hall. From above the 'Sub Olean' conglomerate one mile east of Stoneham, Pa. Nat size. P. 72.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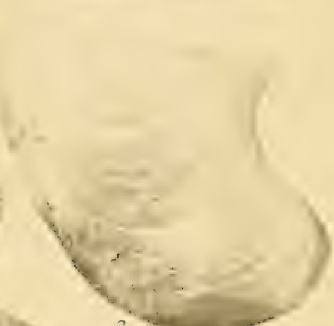
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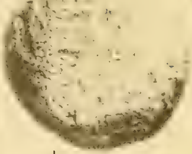
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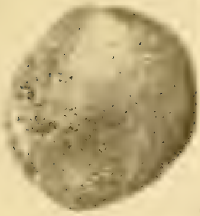
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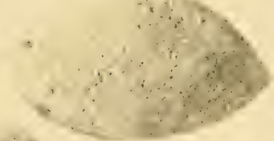
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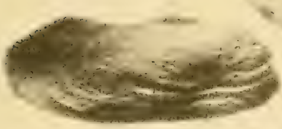
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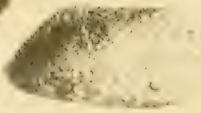
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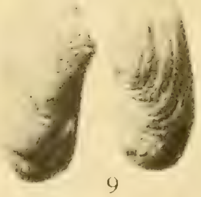
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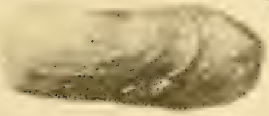
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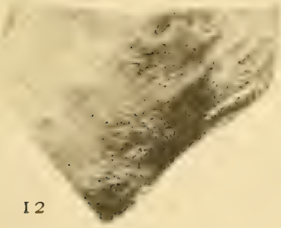
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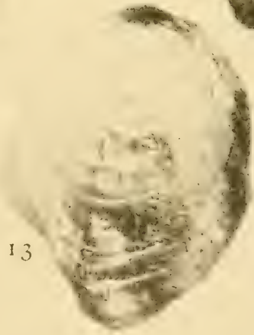
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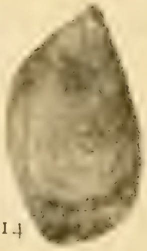
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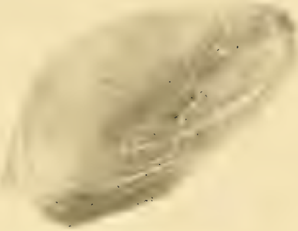
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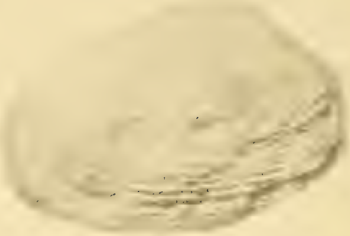
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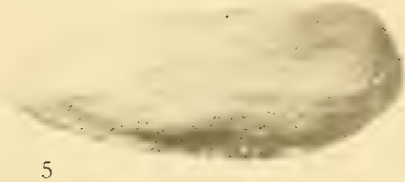
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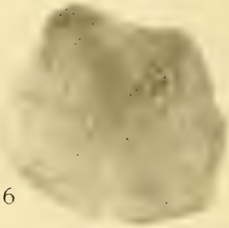
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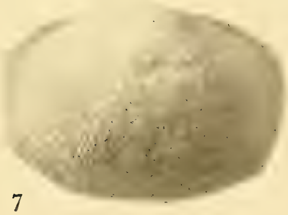
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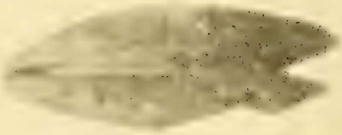
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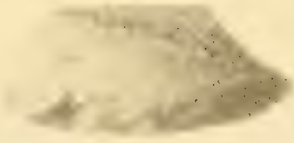
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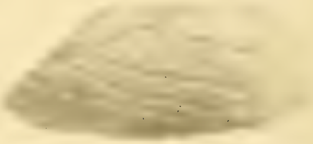
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## Explanation of Plate 42 (63)

FIGURE

1. **Modiola metella** Hall. In a conglomerate near Bradford, Pa. Hingeline 22 mm. P. 73.
2. **Elymella chadwicki,** n. sp. From the Venango First Oil sand horizon on Stone Hill south east of Stoneham, Pa. Length 41 mm. P. 88.
3. **Pararca equilateralis** n. sp. From a light brown conglomeritic sandstone 100 feet above the road at Glade, Pa. Width 33 mm. P. 84.

**contractus** Hall. From the upper Chemung beds, Allegany co., N. Y. Length 35 mm. P. 76.

5. **Sphenotus clavulus** Hall. 4 miles south of Porstville, N. Y., in a coarse brown sandstone. Length 45 mm. P. 76.

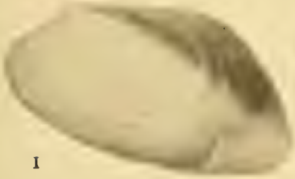
.6 **Pararca erecta** Hall. From the Panama conglomerate at Panama Rocks, N. Y. Height approx. 21 mm. P. 82.

7. **Pararca transversa** Hall. From the Oswayo strata (Knapps Creek) at Flat Iron Station near Olean Rock City, N. Y. Length 15 mm. P. 83.
8. Cardinal view of fig. 1.
9. **Sphenotus palmeræ,** n. sp. From the light brown sandstone 100 feet above the road at Glade, Pa. x 3/2. P. 77.
10. **Sphentous palmeræ,** n. sp. Right valve of fig. 9.

## Explanation of Plate 43 (64)

FIGURE

1. **Modiomorpha rigida** Hall. From Pal. of N. Y., v, i, pl. 41, fig. 15. P. 73.
2. **M. rigida** Hall. **Ibid.** fig. 14.
3. **M. rigida** Hall. **Ibid.**, fig. 16.
4. **Modiomorpha quadrula** Hall. **Ibid.**, pl. 41, fig. 23. P. 73.
5. **M. quadrula** Hall. **Ibid.**, fig. 26.
6. **M. quadrula** Hall. **Ibid.**, fig. 21.
7. **M. quadrula** Hall. **Ibid.**, fig. 22.
8. **M. quadrula** Hall. **Ibid.**, fig. 25.
9. **Schizodus chemungensis** var. **quadrularis** Hall. **Ibid.**, pl. 75, fig. 32. P. 85.
10. **Schizodus oblatus** Hall. **Ibid.**, pl. 75, fig. 43. P. 86.
11. **S. chemungensis** var. **quadrularis** Hall. **Ibid.**, fig. 33. P. 85.
12. **Schizodus oblatus** Hall. **Ibid.**, fig. 44.
13. **Schizodus cuneus** Hall. **Ibid.**, fig. 29. P. 86.
14. **S. cuneus** Hall. **Ibid.**, fig. 30.
15. **Sanguinolites (?) undulatus** Hall. **Ibid.**, pl. 64, fig. 1. P. 89.
16. **Schizodus chemungensis**, var. **quadrularis** Hall. **Ibid.**, pl. 75, fig. 31.
17. **Schizodus rhombeus** Hall. **Ibid.**, pl. 75, fig. 20. P. 85.
18. **S. rhombeus** Hall. **Ibid.**, fig. 23.
19. **Sanguinolites undulatus** Hall. **Ibid.**, pl. 64, fig. 2. P. 89.
20. **Sanguinolites subtruncatus** Hall. **Ibid.**, fig. 4. P. 89.
21. **S. subtruncatus** Hall. **Ibid.**, fig. 3.
22. **Schizodus rhombeus** Hall. **Ibid.**, pl. 75, fig. 19. P. 85.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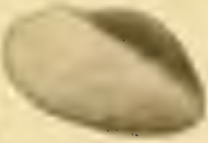
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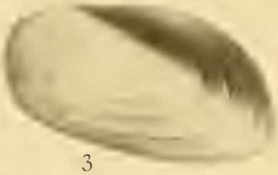
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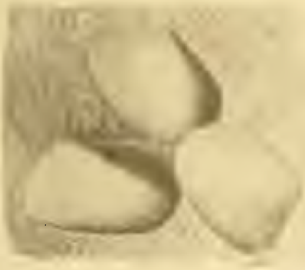
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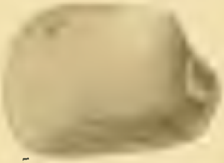
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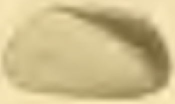
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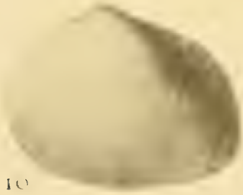
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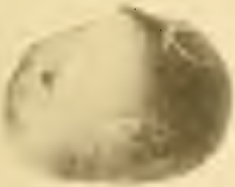
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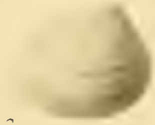
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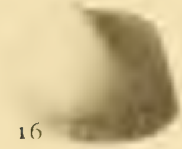
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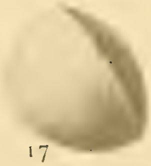
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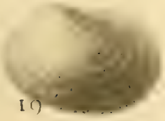
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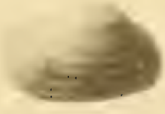
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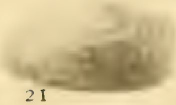
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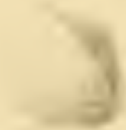
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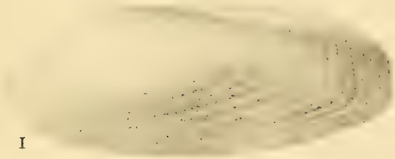
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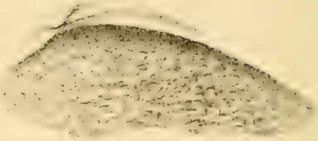
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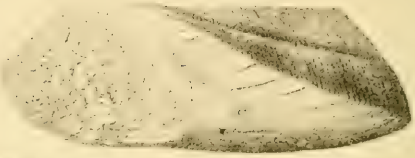
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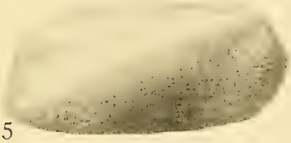
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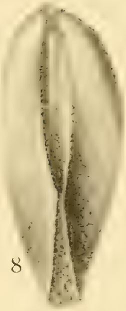
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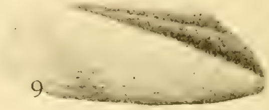
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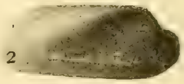
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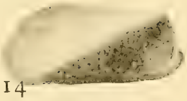
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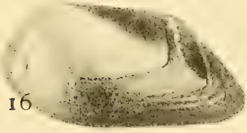
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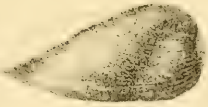
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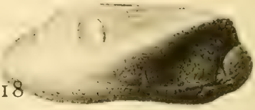
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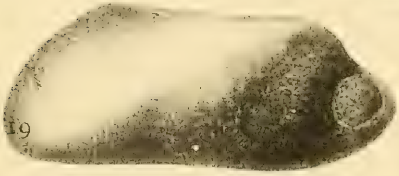
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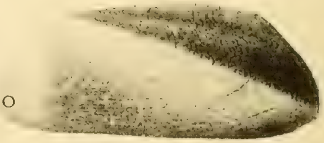
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## EXPLANATION OF PLATE 44 (65)

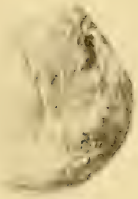
FIGURE

1. **Sphenotus signatus** Hall. From Pal. of N. Y., v, i, pl. 94, fig. 3. P. 77.
2. **Sphenotus contractus** Hall. **Ibid.**, pl. 66, fig. 11. P. 76.
3. **Sphenotus clavulus** Hall. **Ibid.**, fig. 24. P. 76.
4. **S. contractus** Hall. **Ibid.**, pl. 66, fig. 15.
5. **Sphenotus rigidus** Hall. **Ibid.**, pl. 66, fig. 14, from the Chemung.
6. **Sphenotus flavius** Hall. **Ibid.**, fig. 28, from the Chemung.
7. **S. clavulus** Hall. **Ibid.**, fig. 21.
8. **S. flavius** Hall. **Ibid.**, fig. 29.
9. **S. contractus** Hall. **Ibid.**, fig. 4. P. 76.
10. **S. contractus** Hall. **Ibid.**, fig. 2.
11. **S. contractus** Hall. **Ibid.**, fig. 3.
12. **S. contractus** Hall. **Ibid.**, pl. 94, fig. 2.
13. **S. clavulus** Hall. **Ibid.**, pl. 66, fig. 20. P. 76.
14. **S. contractus** Hall. **Ibid.**, fig. 10.
15. **S. contractus** Hall. **Ibid.**, fig. 9.
16. **S. contractus** Hall. **Ibid.**, fig. 17.
17. **S. contractus** Hall. **Ibid.**, pl. 66, fig. 6.
18. **S. contractus** Hall. **Ibid.**, fig. 8.
19. **Sphenotus (?) arcuatus** Hall. **Ibid.**, pl. 66, fig. 18, P. 76.
20. **S. contractus** Hall. **Ibid.**, fig. 13.

## EXPLANATION OF PLATE 45 (66)

FIGURE

1. **Paracyclas erecta** Hall. Conewango beds at Glade, Pa. Nat. size. P. 85.
2. **Grammysia duplicata** Hall. From Pal. of N. Y., v, i, pl. 93, fig. 23. P. 75.
3. **Grammysia undata** Hall. **Ibid.**, pl. 61, fig. 23. P. 75.
4. **G. undata** Hall. **Ibid.**, pl. 64, fig. 30.
5. **Grammysia subnasuta** Tall. **Ibid.**, pl. 64, fig. 6. P. 75.
6. **Grammysia glabra** Hall. **Ibid.**, pl. 93, fig. 24. P. 75.
7. **Grammysia communis** Hall. **Ibid.**, pl. 61, fig. 28. P. 75.
8. **G. communis** Hall. **Ibid.**, pl. 61, fig. 26.
9. **G. communis** Hall. **Ibid.**, pl. 61, fig. 25.
10. **G. communis** Hall. **Ibid.**, pl. 61, fig. 24.
11. **Paleanatina angusta** Hall.. **Ibid.**, pl. 79, fig. 32. P. 88.
12. **Paleanatina typa** Hall. **Ibid.**, pl. 79, fig. 26. P. 88.
13. **P. typa** Hall. **Ibid.**, fig. 36.
14. **P. angusta** Hall. **Ibid.**, pl. 79, fig. 30.
15. **P. typa** Hall. **Ibid.**, fig. 28.
16. **P. angusta** Hall. **Ibid.**. fig 34.
17. **P. angusta** Hall. **Ibid.**, fig. 31.
18. **P. angusta** Hall. **Ibid.**, fig. 33.
19. **P. typa** Hall. **Ibid.**, fig. 37.
20. **P. typa** Hall., **Ibid.**, pl. 79, fig. 37.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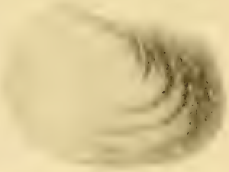
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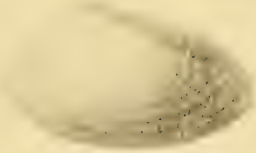
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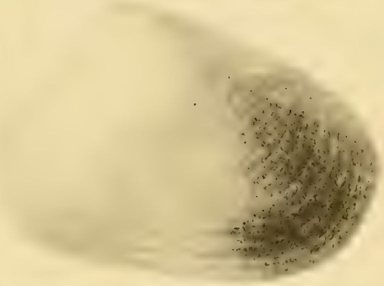
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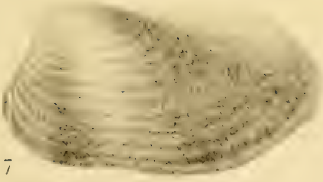
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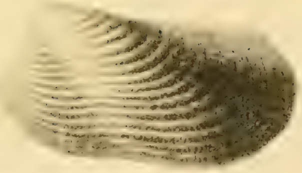
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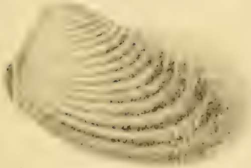
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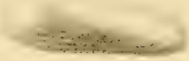
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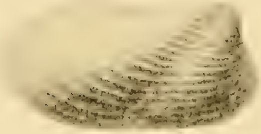
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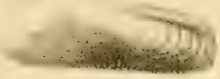
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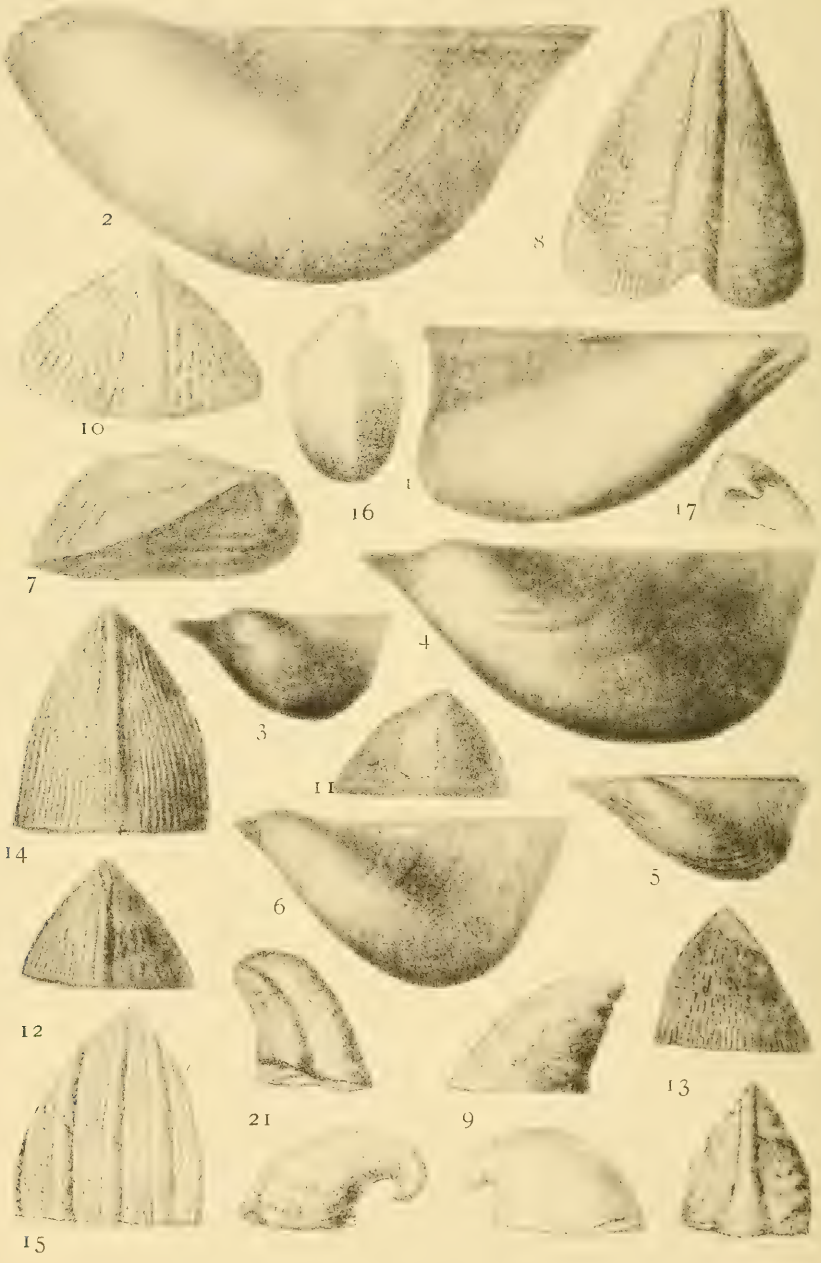
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## EXPLANATION OF PLATE 46 (67)

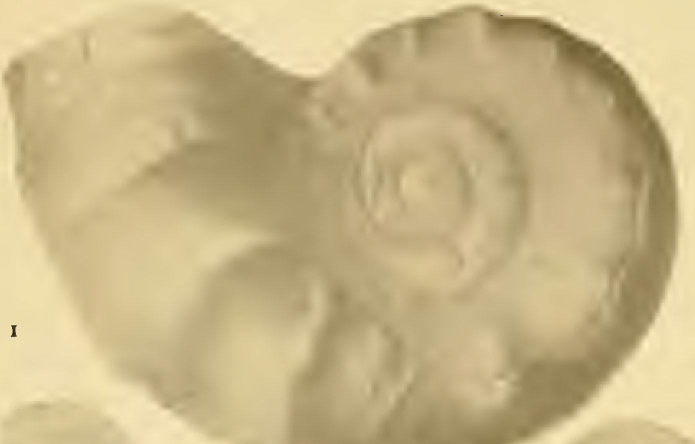
FIGURE

1. **Leptodesma aliforme** Hall. From Pal. of N. Y., v. i, pl. 22, fig. 28.
2. **Pteronites profundus** Hall. **Ibid.**, pl. 22, fig. 27. P. 58.
3. **Pteronites rostratus** Hall. **Ibid.**, fig. 24. P. 58.
4. **Pteronites profundus** Hall. **Ibid.**, fig. 28.
5. **Leptodesma extenuatum** Hall. **Ibid.**, pl. 22, fig. 23.
6. **Pteronites profundus** Hall. **Ibid.**, fig. 25.
7. (?) **Goniophora curvata** Simpson. Tr. Am. Phil. Soc., n. s. 16, 1889, p. 450, fig. 18, P. 78.
8. **Platyceras dorsale** Simp. **Ibid.**, p. 454, fig. 24, no. 2. P. 90.
9. **Platyceras dorsale** Simp. **Ibid.**, fig. 24, no. 1.
10. **Platyceras breve** Simp. **Ibid.**, p. 454, fig. 23, no. 4. P. 90.
11. **Platyceras breve** Simp. **Ibid.**, fig. 23, no. 3.
12. **Platyceras breve** Simp. **Ibid.**, fig. 23, no. 1.
13. **Platyceras breve** Simp. **Ibid.**, fig. 23, no. 2.
14. **Platyceras striatum** Simpson. **Ibid.**, p. 457, fig. 27, no. 1. P. 90.
15. **Platyceras striatum** Simp. **Ibid.**, fig. 27, no. 2.
16. **Platyceras inæquale** Simp. **Ibid.**, p. 456, fig. 25, no. 2. P. 90.
17. **Platyceras inæquale** Simp. **Ibid.**, fig. 25, no. 1.
18. **Platyceras inæquale** Simp. **Ibid.**, fig. 25, no. 3.
19. **Platyceras mitelliforme** Simp. **Ibid.**, p. 456 ,fig. 26, no. 1, P. 90.
20. **Platyceras mitelliforme** Simp. **Ibid.**, fig. 26, no. 2.
21. **Platyceras varians** Simp. **Ibid.**, p. 458, fig. 28. P. 90.

## EXPLANATION OF PLATE 47 (68)

FIGURE

1. **Gyroceras stebos** Hall. From Pal. of N. Y., vii, pl. 125, fig. 7. P. 94.
2. **Bellerophon leda** Hall. From Pal. of N. Y., v, ii, pl. 26, fig. 24, a Hamilton form, for comparison.
3. **Bellerophon maera** Hall. **Ibid.**, pl. 26, fig. 19. P. 89.
4. **B. maera** Hall. **Ibid.**, fig. 21.
5. **B. maera** Hall. **Ibid.**, pl. 25, fig. 12.
6. **B. maera** Hall. **Ibid.**, pl. 26, fig. 20.
7. **B. maera** Hall. **Ibid.**, fig. 22.
8. **B. maera** Hall. **Ibid.**, fig. 13.
9. **Euomphalus hecale** Hall. **Ibid.**, pl. 16, fig. 13. P. 90.
10. **E. hecale** Hall. **Ibid.**, fig. 10.
11. **E. hecale** Hall. **Ibid.**, fig. 14.
12. **E. hecale** Hall. **Ibid.**, fig. 12.
13. **E. hecale** Hall. **Ibid.**, fig. 11.



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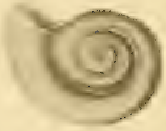

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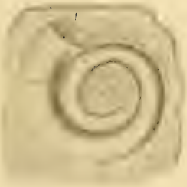

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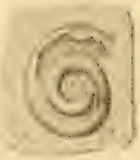

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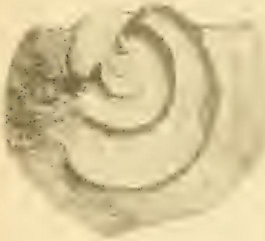
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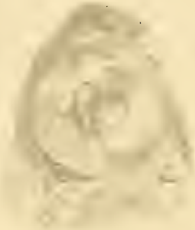
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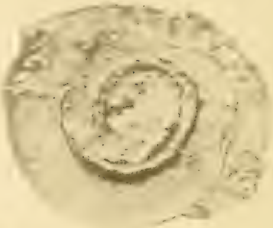
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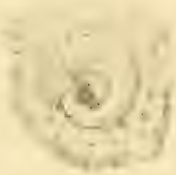
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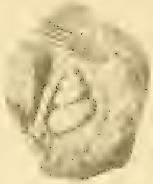
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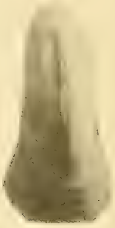
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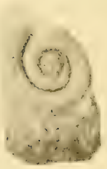
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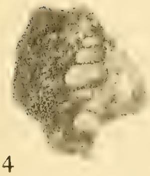
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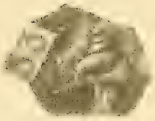
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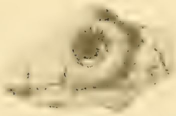
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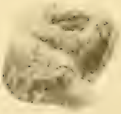
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## EXPLANATION OF PLATE 48 (69)

FIGURE

1, 2, 13. **Euomphalus hecale** Hall. From the Panama conglomerate at Panama Rocks near the Checkered School House, Chautauqua co., N. Y. Nat. size. P. 90.

3. **Pleurotomaria,** sp. Venango First Oil sand horizon on Stone Hill near Stoneham, Pa. Height 7 mm. P. 92.

4, 5. **Platyceras ruedemanni,** n. sp. 1½ mile east of Glade, Pa., in a chocolate colored sandstone (weathered limy sandstone) which is at the Oswayo horizon. Nat. size. P. 91.

6. **Bellerophon,** sp. From the Conewango formation at Glade, Pa. Nat. size.

7. **Platyceras,** sp. A warped internal mould from the Venango First Oil sand horizon just east of the Cobham monument. Nat size.

8, 9. **Platyceras,** sp. From the same faunule as fig. 7. Nat. size.

10. **Pleurotomaria,** sp. From the same faunule as fig. 3. Nat size.

11. **Platyceras,** sp. From the faunule of fig. 3. Nat size.

12. **Pleurotomaria,** sp. External cast. From the faunule of fig. 7.

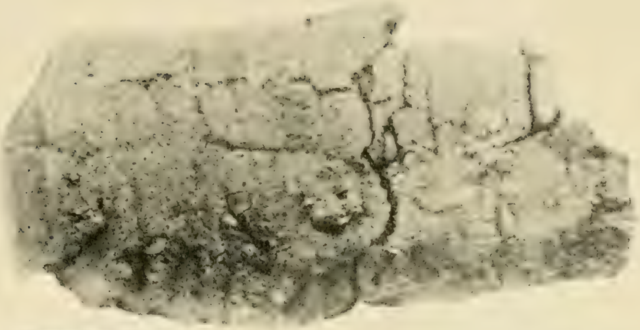
14, 15. **Pleurotomaria,** sp. From the faunule of fig. 3.

16, 17. **Bellerophon ?,** sp. From the faunule of fig. 7. Slightly enlarged.

## EXPLANATION OF PLATE 49 (70)

FIGURE

1. **Orthoceras**, sp. From the highest conglomerate on the top of Robins Hill, about one mile east of the Chautauqua-Cattaraugus county line, N. Y. P. 93.
2. **Orthoceras**, sp. A cast of a septum of fig. 1.
3. **Gomphoceras**, sp. From the light brown sandstone 100 feet above the road at Glade, Pa., P. 94.
4. **Cyrtoceras hector** Hall. From Pal. of N. Y., v, ii, pl. 90, fig. 14. P. 94.
5. **Cyrtoceras hector**, Hall. **Ibid.**, fig. 11.
6. **Gomphoceras nasutum** Hall. **Ibid.**, vol. vii, pl. 120, fig. 5. P. 94.
7. **Orthceras**, sp. From the horizon of the Venango First Oil sand one mile east of Stoneham, Pa., P. 93.
8. **Orthoceras leander** Hall. From Pal. of N. Y., v, ii, pl. 90, fig. 7. P. 93.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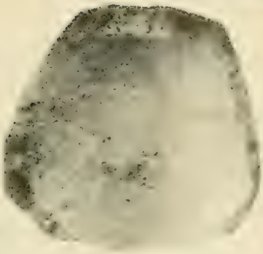
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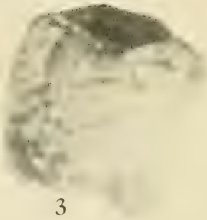
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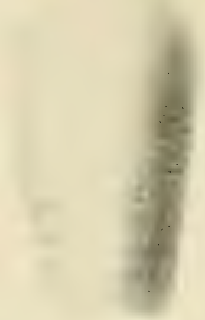
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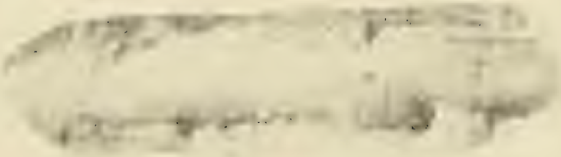
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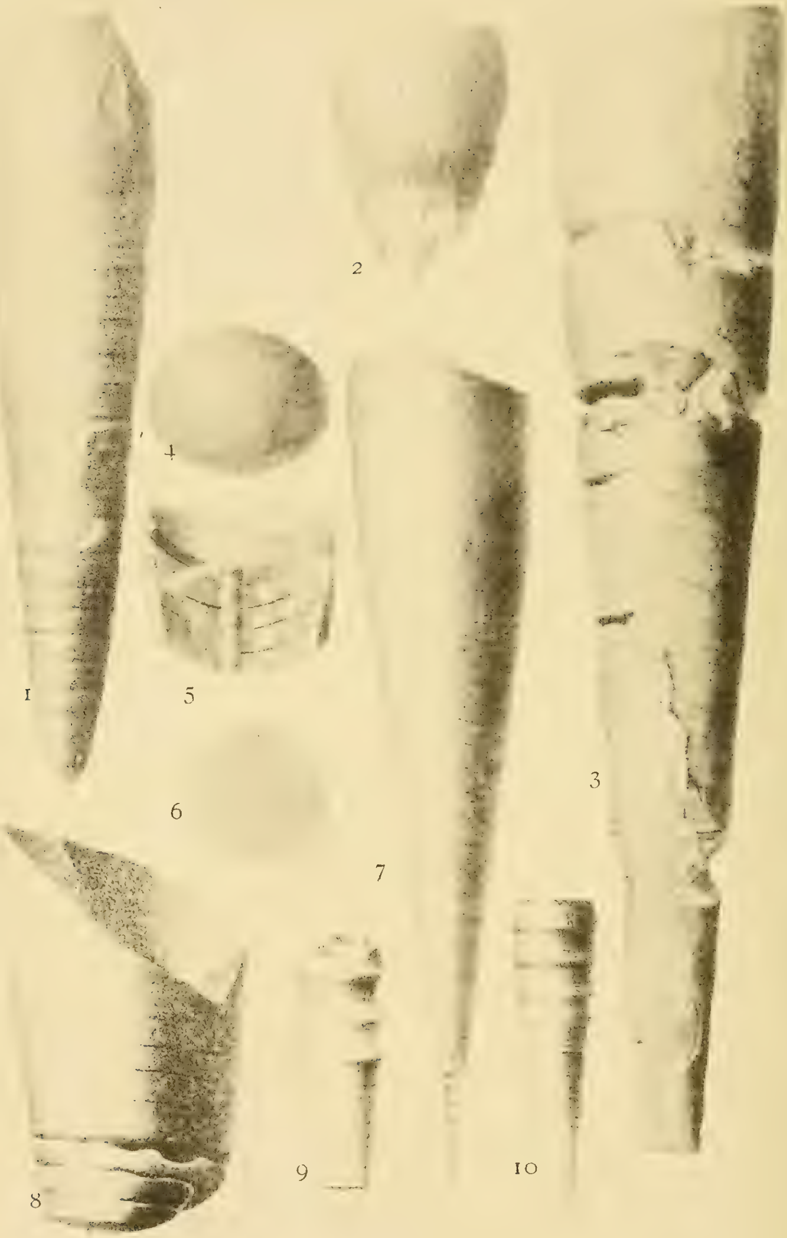
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## EXPLANATION OF PLATE 50 (71)

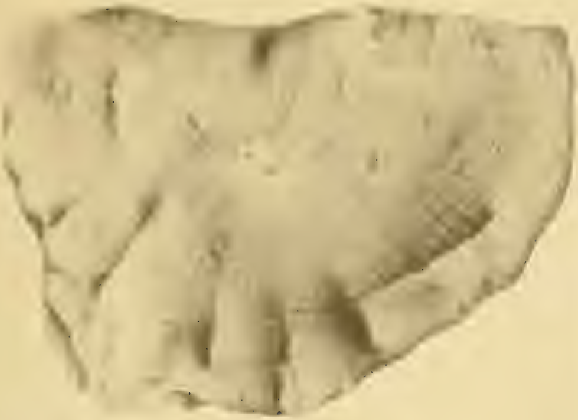
FIGURE

1. **Orthoceras leander** Hall. From Pal. of N. Y., v, ii, pl. 90, fig. 8. P. 93.
2. **Gomphoceras tumidum** Hall. **Ibid.**, pl. 95, fig. 5, P. 94.
3. **Orthoceras consortale** Hall. **Ibid.**, Supp. to vii, pl. 118, fig. 3, x approx. 5/6 Hall's illustration. P. 93.
4. **Orthoceras consortale Ibid.**, fig. 5. Same reduction.
5. **Orthoceras consortale** Hall. **Ibid.**, fig. 4.
6. **Gomphoceras nasutum** Hall. (See plate 49) Transverse view showing the position of the siphuncle. **Ibid.**, Supp. to vii, pl. 120, fig. 7, P. 94.
7. **Orthoceras warrenense** Miller, (**O. cochleatum** Hall). From Pal. of N. Y., v, ii, pl. 113, fig. 19, P. 93.
8. **Cyrtoceras hector** Hall. **Ibid.**, pl. 92, fig. 12, P. 94.
9. **Orthoceras bipartitum** Hall. **Ibid.**, pl. 113, fig. 20, P. 93.
10. **O. bipartitum** Hall. **Ibid.**, fig. 21.

## EXPLANATION OF PLATE 51 (72)

FIGURE

1. **Thysanodictya expansa** Hall. From Rep. N. Y. S. Geol., 1896, pl. 53, fig. 3. x 1/2 Hall's figure. P. 96.
2. **Hydnoceras nodosum** Hall. **Ibid.**, pl. 2, fig. 2. Nat size. P. 95.
3. **Tylodictya ? tenuis** Hall. **Ibid.**, pl. 53, fig. 5, Nat. size. P. 96.
4. **Thysanodictya randalli** Hall. **Ibid.**, pl. 24, fig. 12, x 6/7 Hall's fig. P. 96.
5. **Ectenodictya implexa** Hall. **Ibid.**, pl. 54, fig. 4. Nat. size. P. 97.



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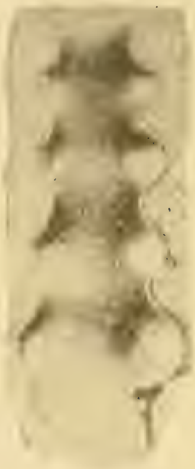

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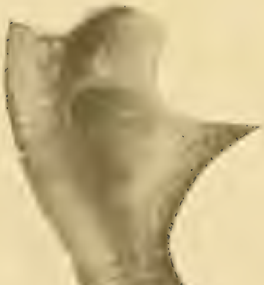

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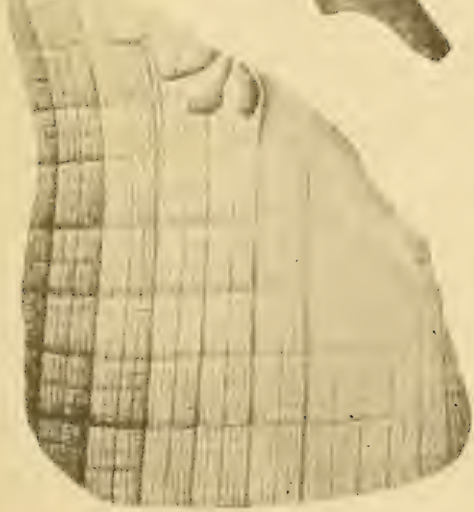

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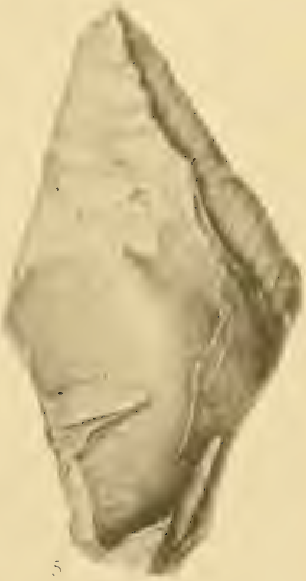

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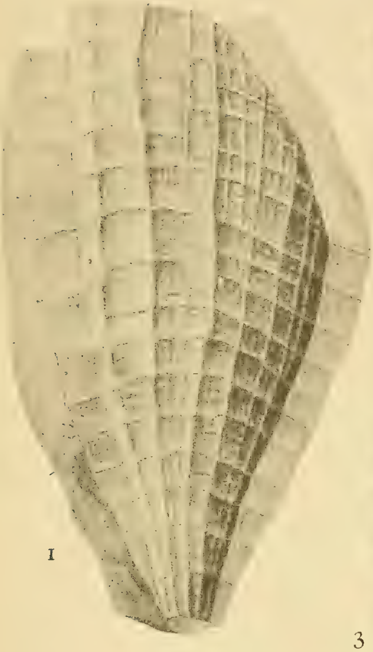
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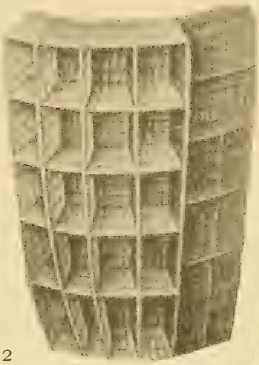
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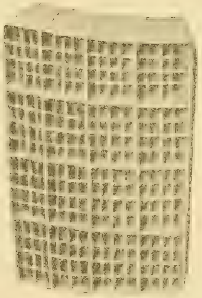
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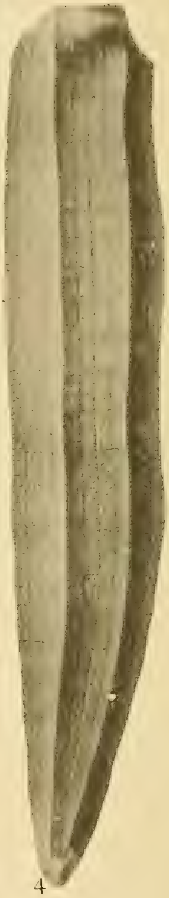
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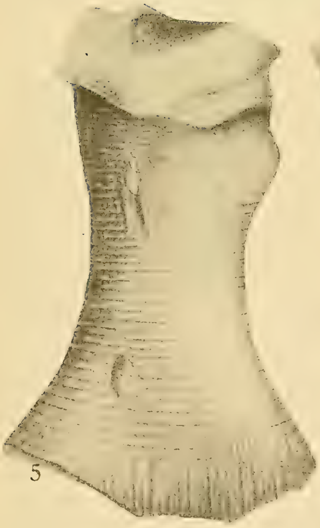
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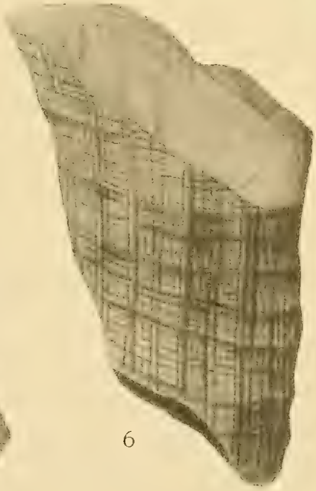
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EXPLANATION OF PLATE 52 (73)

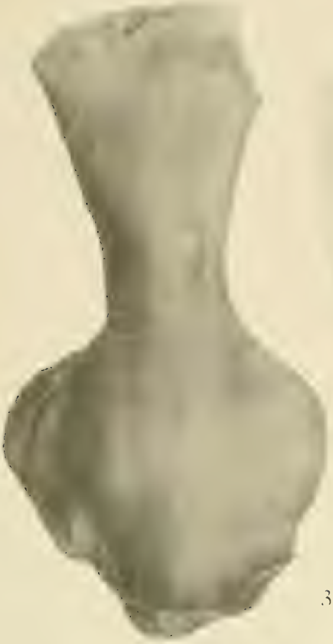
FIGURE

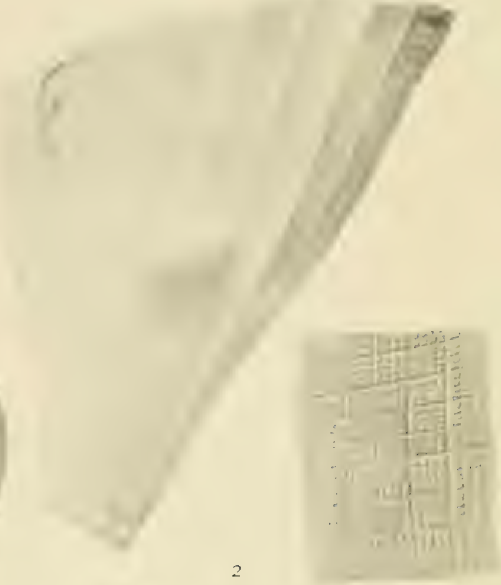
1. **Clathrospongia abacus** Hall. From the Rep. of the N. Y. S. Geol., for 1896, pl. 49, fig. 5. x 17/20 Hall's fig. P, 96.
2. **C. abacus** Hall. **Ibid.**, fig. 6. Nat. size. P. 96.
3. **Clathrospongia abacus** Hall. **Ibid.** fig. 6 Nat. size. P. 96.
4. **Prismodictya conradi** Hall. **Ibid.**, pl. 19, fig. 6. x 11/13 Hall's fig., P. 95.
5. **Calathospongia carli** Hall. **Ibid.**, pl. 52, fig. 6. x 13/17 Hall's fig., P. 96.
6. **Clathrospongia abacus** Hall., pl. 49, fig. 8. Nat. size, P. 96.

## Explanation of Plate 53 (74)

FIGURE

1. **Calathospongia redfieldi** Hall. From the Rep. of the N. Y. S. Geol., 1896, pl. 49, fig. 2. x 17/40 Hall's fig. P. 96.
2. **C. redfieldi** Hall. **Ibid.,** fig. 4. x 5/6 Hall's fig.
3. **Prismodictya choanea** Hall. **Ibid.,** pl. 19, fig. 1. x 17/24 Hall's fig. P. 95.
4. **Tylodictya warrenensis** Hall. **Ibid.,** p. 343 text fig. x 7/8 Hall's fig. P. 96.
5. **Prismodictya allegania** Hall. **Ibid.,** pl. 20, fig. 4. x 8/25 Hall's fig. P. 95.
6. **Prismodictya prismatica** Hall. **Ibid.,** pl. 21, fig. 6. x 8/9 Hall's fig. P. 95.





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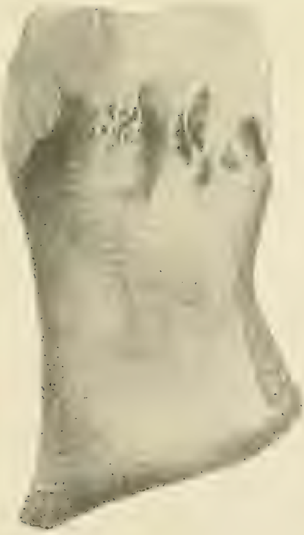

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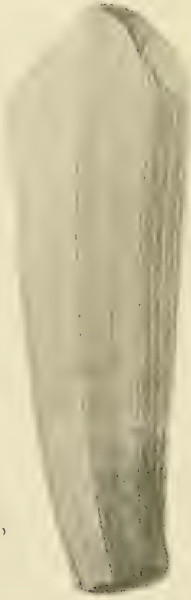

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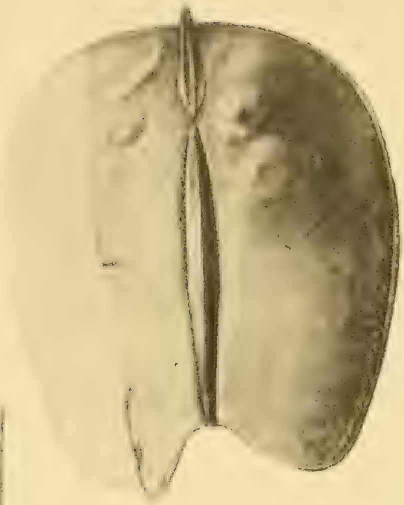

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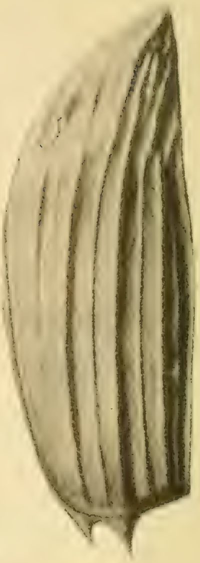

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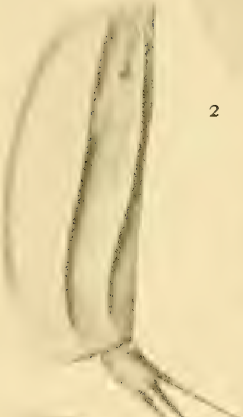

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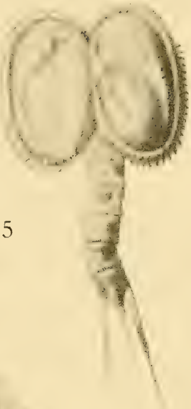

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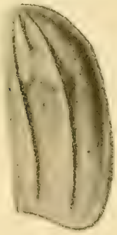

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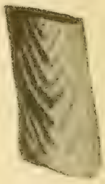

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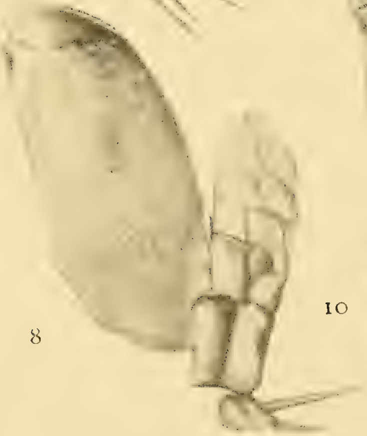

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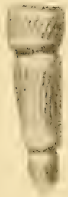

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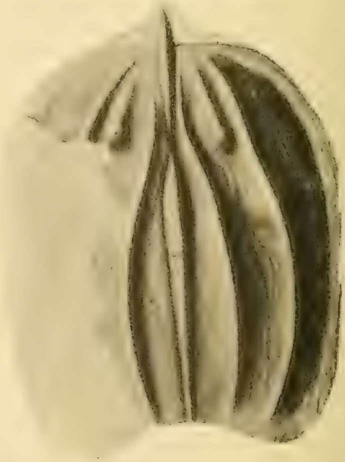


## EXPLANATION OF PLATE 54 (75)

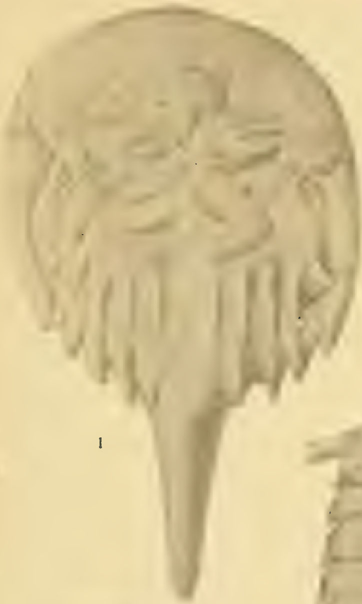
FIGURE

1. **Tropidocaris bicarinata** Beecher. From Geol. Journ. 58, 1902, pl. 19, fig. 2. P. 97.
2. **Elymocaris siliqua** Beecher. **Ibid.**, pl. 19, fig. 8. P. 98.
3. **Tropidocaris bicarinata** Beecher. **Ibid.**, fig. 6.
4. **Tropidocaris bicarinata** Beecher. **Ibid.**, fig. 3.
5. **Echinocaris clarkii** Beecher. **Ibid.**, pl. 18, fig. 9. P. 97.
6. **Tropidocaris bicarinata** Beecher. **Ibid.**, pl. 19, fig. 4.
7. **Tropidocaris bicarinata** Beecher. **Ibid.**, fig. 1.
8. **Elymocaris siliqua** Beecher. **Ibid.**, pl. 19, fig. 7.
9. **Tropidocaris bicarinata** Beecher. **Ibid.**, fig. 5.
10. **Tropidocaris bicarinata** Beecher. From the Pal. of N. Y., vii, pl. 31,

## EXPLANATION OF PLATE 55 (76)

FIGURE

1. **Protolimulus eriensis** (Wms) From Hall, Pal. of N. Y., vii, pl. 27, fig. 1, P. 99.
2. **Protolimulus eriensis** (Wms) From the green shales at the ceramic quarry at Lewis Run near Bradford, Pa.
3. **Stylonurus beecheri** (Hall) From Pal. of N. Y., vii, pl. 27, fig. 5, P. 98.
4. **Echinocaris socialis** Beecher. From the Geol. Journ., 118, fig. 1, P. 97.
5. **Echinocaris randalli** Beecher. **Ibid.**, pl. 18, fig. 8, P. 97.
6. **Echinocaris socialis** Beecher. **Ibid.**, fig. 4.
7. **Echinocaris socialis** Beecher. **Ibid.**, fig. 3.
8. **Echinocaris socialis** Beecher. **Ibid.**, fig. 2.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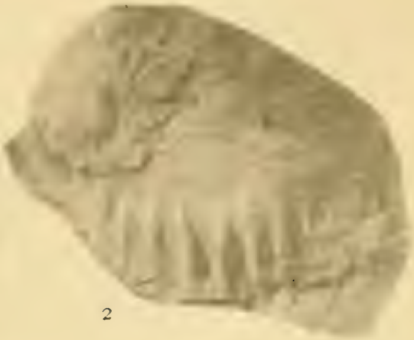
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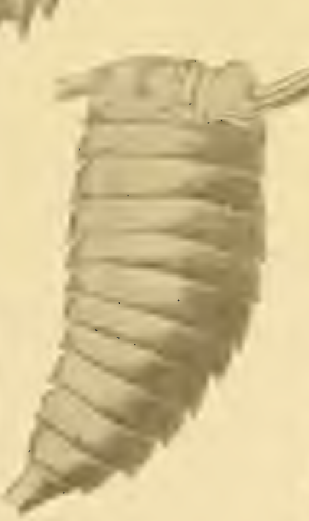
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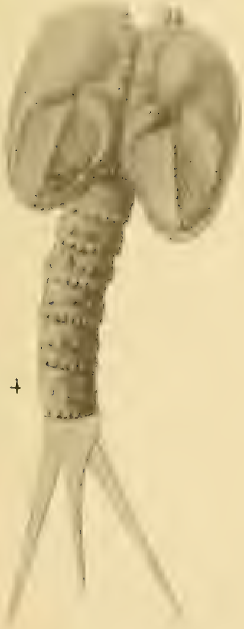
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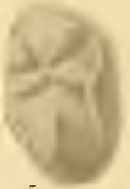
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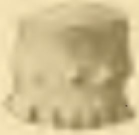
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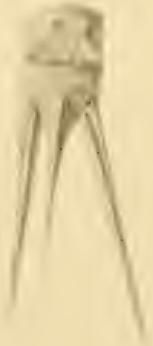
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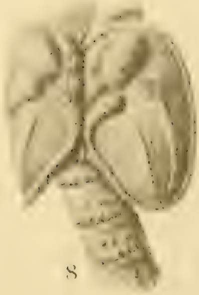
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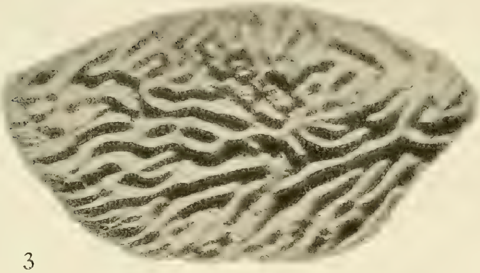
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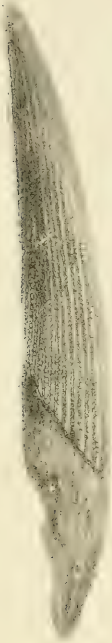
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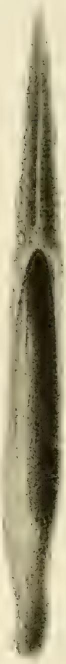
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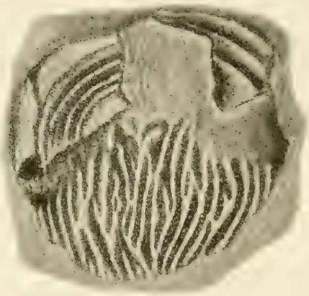
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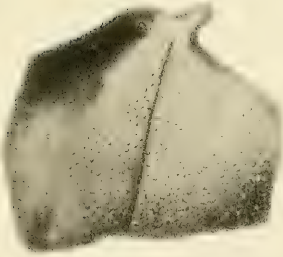
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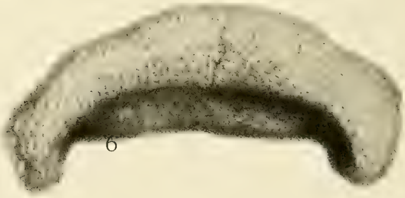
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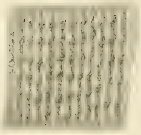
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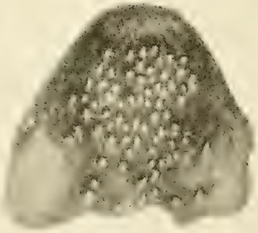
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## EXPLANATION OF PLATE 56 (77)

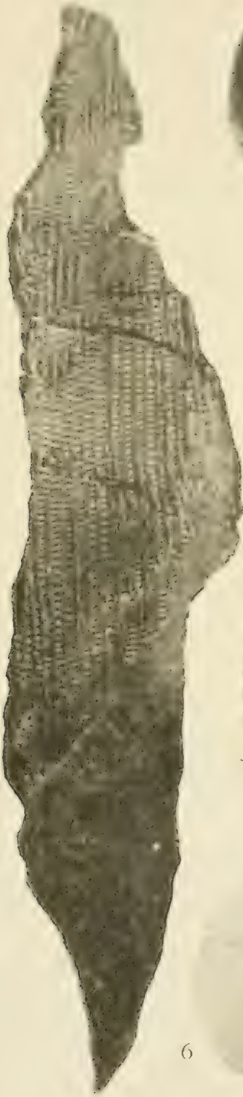
FIGURE

1. **Ctenacanthus triangularis** Newb. From Pal. of Ohio, Impl., 36, fig. 1. P. 102.
2. **C. triangularis Ibid.,** fig. 1a.
3. **Holonema rugosa** Claypole. From below the second conglomerate at Bradford, Pa., P. 104.
4. **Holoptychus americanus** Leidy. From Mon. U. S. G. S. No. 16, pl. 19, fig. 13. P. 104.
5. **Dinichthys tuberculatus** Newb. **Ibid.,** pl. 37, fig. 3, P. 104.
6. **Ganorhynchus beecheri** Newb. **Ibid.,** pl. 19, fig. 2. P. 105.
7. **Dipterus nelsoni** Newb. From Dev. Fishes of N. Y., pl. 4, fig. 15, P. 105.
8. **D. nelson** Newb. **Ibid.,** fig. 14.
9. **Ctenacanthus chemungensis** East. **Ibid.,** pl. 7, fig 3, P. 102.
10. **Holoptychus pustulosus** Newb. Mon. U. S. G. S., No. 16, pl. 20, fig. 11. P. 104.

## EXPLANATION OF PLATE 57 (78)

FIGURE

1. **Ctenacanthus harrisi** n. sp. From the Oswayo sandstone east of Mt. Jewitt, Pa. Nat. size. approx. P. 103.
2. **Holoptychus taylori** (Hall)? From the Chemung beds at Bradford, Pa. Greatest width 38 mm. P. 104.
3. **Rhadinichthys** sp. nov. East. From the Dev. Fishes of N. Y., pl .19, fig. 4. P. 105.
4. **Bothriolepis minor** Newb. From Mon. U. S. G. S., No. 16, pl. 20, fig. 7. P. 106.
5. **Holoptychus americanus** Leidy. **Ibid.**, pl., 19, fig. 12, P. 104.
6. **Rhadinichthys**, sp. nov. East. (See fig. 3), pl. 4, fig. 11. P. 105.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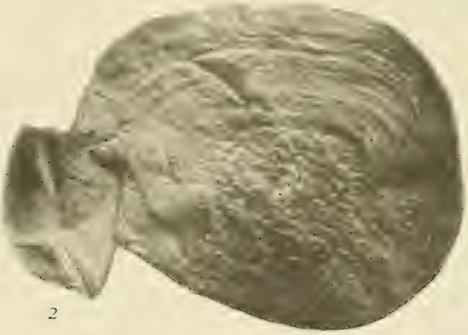
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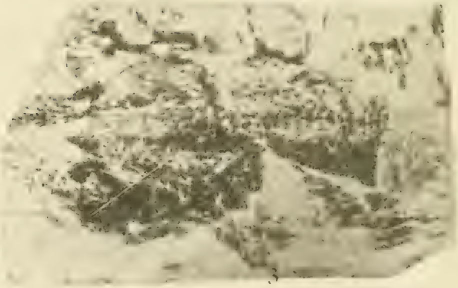
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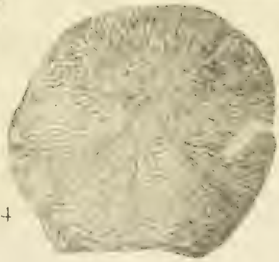
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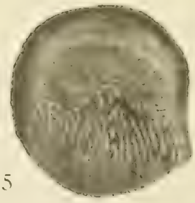
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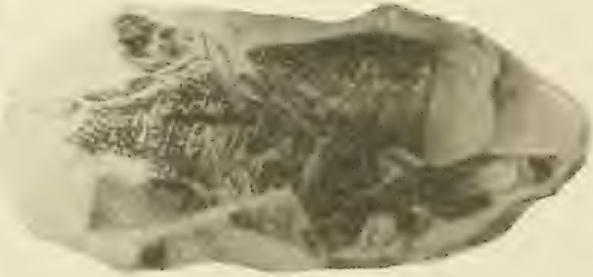
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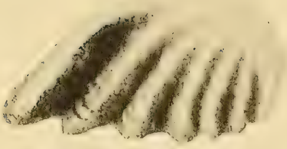
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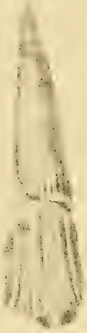
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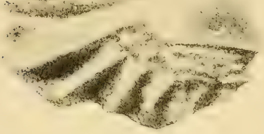
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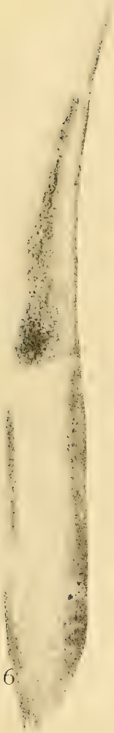
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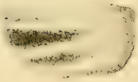
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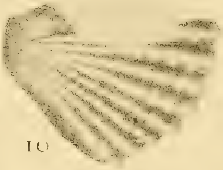
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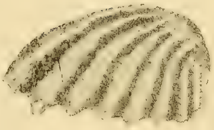
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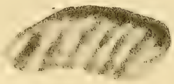
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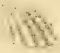
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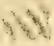
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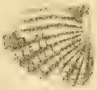
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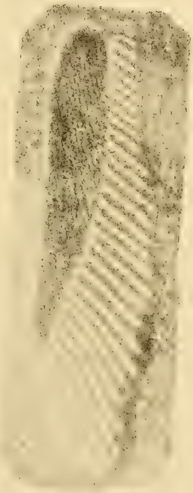
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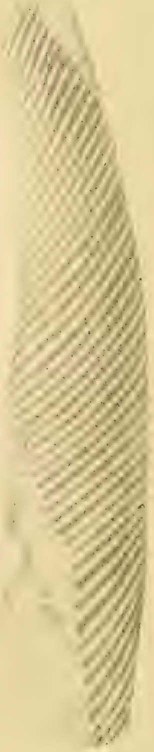
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## EXPLANATION OF PLATE 58 (79)

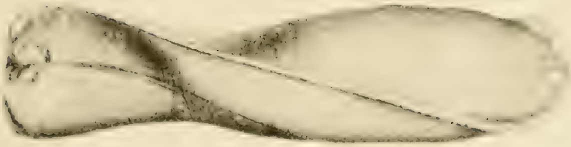
FIGURE

1. **Dipterus (Ctenodus) nelsoni** Newb. Mon. U. S. G. S., No. 16, pl. 27, fig. 19. P. 105.
2. **Dipterus Ctenodus levis** Newb. **Ibid.**, pl., 27, fig. 22. P. 105.
2. **Dipterus (Ctenodus) levis** Newb. **Ibid.**, pl. 27, fig. 22. P. 105.
3. **Homacanthus acinaciformis** East. From Dev. Fishes of N. Y., pl. 1, fig. 16. P. 106.
.. **Apedodus priscus** Leidy. **Ibid.**, pl. 1, fig. 1, P. 106.
6. **Gyracanthus sherwoodi** Newb. From Mon. U. S. G. S., No. 16, pl. 18, fig. 4. P. 106.
7. **Gyracanthus sherwoodi** Newb. **Ibid.**, fig. 4a.
8. **Gyracanthus sherwoodi** Newb. From Dev. Fishes of N. Y., pl. 3, fig. 7.
9. **Dipterus (Ctenodus) levis** Newb. Mon. U. S. G. S., No. 16, pl. 27, fig. 23.
10. **Dipterus (Ctenodus) flabelliformis** Newb. **Ibid.**, pl. 27, fig. 21. P. 105.
11. **Dipterus (Ctenodus) nelsoni** Newb. **Ibid.**, fig. 20. P. 105.
12. **Sagenodus** sp. From Dev. Fishes of N. Y., pl. 1, fig. 13. P. 106.
13. **Dipterus (Ctenodus) quadratus** Newb. Mon. U. S. G. S., No. 16, pl. 27, fig. 24. P. 105.
14. **Dipterus (Ctenodus) quadratus** Newb. **Ibid.**, fig. 25.
15. **Dipterus (Ctenodus) minutus** Newb. **Ibid.**, pl. 27, fig. 26. P. 105.
16. **Dipterus (Ctenodus) flabelliformis** Newb. **Ibid.**, fig. 21a.

## EXPLANATION OF PLATE 59 (80)

FIGURE

1. **Spirodomus insignis** Beecher. From 39th Rep. N. Y. S. Mus Nat. Hist., pl. 12, fig. 4. P. 82.
2. **Spirodomus insignis** Beecher. **Ibid.**, fig. 5. P. 97.
3. **Tropidocaris interrupta** Beecher. From Pal. of N. Y., vii, pl. 31, fig. 13. P. 97.
4. **Tropidocaris alternata** Beecher. **Ibid.**, fig. 15. P. 97.
5. **Tropidocaris alternata** Beecher. **Ibid.**, fig. 14.
6. **Prestwichia randalli** Beecher. From Amer. Geol., 29, 1902, p. 143. P. 98.
7. **Eurypterus pennsylvanicus** C. E. Hall. 2nd. Pa. Geol. Surv. Rep. pl. 5, fig. 18. P. 98.
8. **Thinopus antiquus** Marsh. From Morton, D. J. Am. Journ. of Sc., n. s. 71, no. 12, 1927, p. 409. P. 107.
9. **Thinopus antiquus** Marsh. **Ibid.**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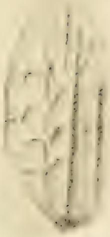
3

7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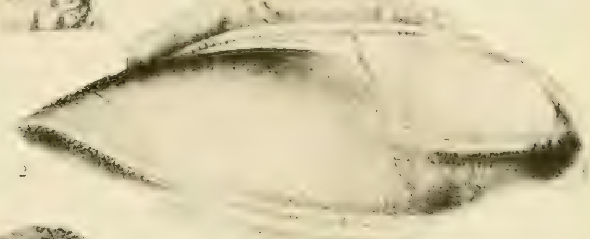
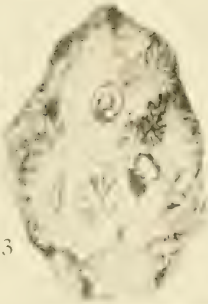

2

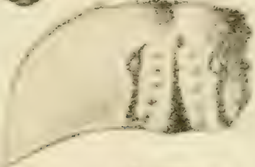
12

10

11


13

5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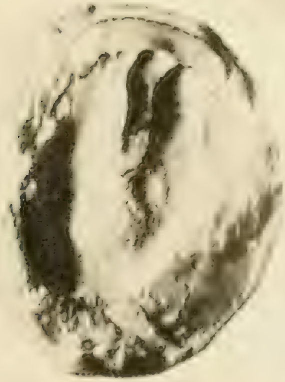
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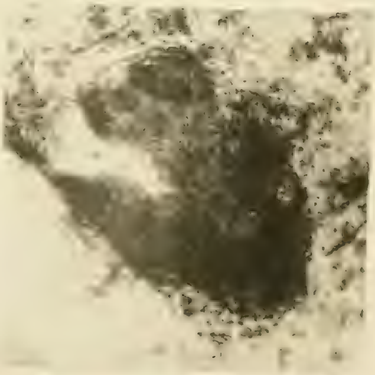
9

# INDEX TO VOLUME 15

**Note: Figures refer to the continuous numbering of the volume (not of the separate bulletins); black face numerals refer to plates; light face, to pages.**

A
Actinopteria alpha **46** 206
  beta **46** 207
Admete luffa **16** 93
Ambocoelia gregaria **32** 180
  umbonata var. gregaria **32** 180
Andicula n. gen 94
Anomalina affinis 32
  mantaensis **4** 28
  wuellerstorfi **4** 31
Anomia (?) Archinacella
  (?) incerta **62** 234
Apedodus priscus **79** 248
Arca saladoensis **9** 70
  samanensis **8** 71
Argyrotheca berryi **9** 100
  wegemanni **17** 119
Asterigerina subacuta 135
Athyris angelica **30** 177
  lamellosa **32** 180
Aulostomella 24
Aviculopecten aequilata **53** 182
  aequilateralis **52, 53** 183
  cancellatus **54** 183
  celsus **53** 182
  duplicatus **54** 182
  ellipticus **53** 182
  patulus **54** 183
  striatus **53** 182
  tenuis **53** 182

B
Bellerophon maera **68** 231
Boggsia n. gen 78
Bolivina applinae **5** 35
  pisciformis **5** 36
Bonellita 93
Bothriolepis minor **78** 248
Bulimina compressa 133
  inflata **5** 37
  ovata **19** 132

C
Calathospongia carlli **73** 238
  redfieldi **74** 238
Camarotoechia allegania **35** 155
  contracta **33** 152
  orbicularis **33** 157
  sappho **33** 157
Cardium himertum **11** 77
Cassidulina subglobosa **6** 40
Caster, K. E. author of
  Bull. 58 145
Cerithiopsis quemada **14** 87
Cerithium laevisculum **12** 81
  laevisculum saladoense **12** 82
  paytense 81
  restinense **13** 84
Chonetes lepidus **37** 149
  scitulus **37** 149
  setigerus **37** 150
Cibicides alleni **4** 29
  americanus **21** 136
  dohertyi **4** 30
  elongatus **20, 21** 137
  haidengeri **4** 30
  lobatulus **21** 137
  nucleata **4** 31
  pseudoungerianus **20** 137
  ungeriana **4** 31
  wuellerstorfi **4** 31
Cladodus carinatus 248
Claiborne formainifera,
  see Bull. 50, p. 57.
Clathrospongia abacus **73** 238
Clavulina brayamensis
  bryamensis extans **21** 128
  communis pallida 34
  curta **5** 34
  pallida **5** 34
  parisiensis **5** 34
Cole, W. S., author of

Bull. 56 57
  Co-author of Bull. 57b 123
  Oligocene Brachiopod from Mexico Bull. 57a 117
Crania leoni 31 148
Crenipecten amplus 55 184
  crenulatus 55 184
  impolitus 55 184
  leon 56 184
  liratus 56 184
  micropterus 53 184
  winchelli 56 184
Cristellaria calcar 20
  convergens 129
  duracina 21
  midwayensis 128
  occidentalis novangliae 1 11
  rotulata 129
Ctenacanthus chemungensis 77 244
  harrisi 78 245
  randalli 244
  triangularis 77 244
Cypricardinia consimilis 60 229
Cyrtia alta 24 174
Cyrtina triplicata 35 161
Cyrtoceras hector 71 236
D
Dalmanella tenuilineata 32 150
  tioga 38 150
Dalmanites sp. 80 240
Daphnella eupelia 16 98
  salina 16 98
Daucina multicostata 6 42
Dentalina cocoaensis 41
  consobrina 1 15
  emaciata 15
  mesonensis 21 130
  obliquestriata 1 14
  pauperata 1 13
Devono-Carboniferous, see Bull. 145
Diastoma elaenia 14 89
  furnaria 14 89
  geositta 14 88
Dinichthys tuberculatus 77 246
Diplodonta caboblanca 9 76
Dipterus (Ctenodus) flabelliformis 79 247
  levis 79 247
  minutus 79 247
  nelsoni 79 247
  quadratus 79 247
Discina pleurites, see Lingulodiscina
Discorbina 28
Discorbis 29
Discorbis patelliformis 134
  subarcuana 20 133
  vaughani 134
Drillia parina 16 97
E
Echinocaris clarkii 75 239
  randalli 76 239
  socialis 76 239
Ectenodictya 239
Ecuador Foraminifera, see Bull 55 1
Edmondia phillipi 57 221
  rhomboidea 57 221
  subcarinata 57 221
  transversa 57 221
Ellipsolagena ventricosa 6 43
Ellipsonodosaria 41
Elphidium sagrum 132
Elymella chadwicki 63 230
Elymocaris siliqua 75 240
Eponides advena 134
  bryamensis 19 134
  umbonata 26
Euomphalus hecale 68, 69 232
Eurypterus pennsylvanicus 80 240
F
Fissurina carinata 2 22
  globosa 2 22
  orbignyana caribaea 2 22
  staphyllearia 2 23
Flabellina budensis 1 11
Frondicularia striata 1 12
G
Galloway, J. J., co-author of Bull. 55. 1
Ganorhynuchus beecheri 77 247
Gaudryina chilostomata 33
  globulifera 33
  globulifera 2 33
Gillespie, Ruth, co-author of Bull. 57b 123
Glandulina comata 1 13
  laevigata 1 12
Glandulopolymorphina 24
Globigerina apertura 19 135
  bulloides 3, 19 9, 135
  compressa 3 9
  conglomerata 3 9
  eocaenica 19 135
  pseudobulloides 3 10
  rubra 19 136
  trilocularis 3 10
Globorotalia canariensis 3 25
Globulina gibba 132
  ovata 3 24
Gomphoceras nasutum 70 236

tumidum 71 236
Goniophora curvata 67 220
ruedemanni 67a 220
Grammysia communis 66 217
duplicata 66 217
glabra 66 217
subnasuta 66 217
undata 66 217
Guttulina irregularis 131
Gyracanthus sherwoodi 79 248
Gyroceras stebos 68 236
Gyroidina laevis 4 27
nitidula 4 27
soldanii 4 27

H

Harrisianella n. gen 86
Harrisianella peruviana 16 85
Heliodus gibberulus 249
Hemipronites crenistrea, see Orthothetes
Heterestegina antillae 18 125
Holonema rugosa 77 246
Holoptychus americanus 78 246
pustulosus 77 247
taylori 78 246
Homacanthus acinaciformis 79 248
Hopkinsiana n. subgen 84
Hydnoceras nodosum 73 237

I

Iddingsia n. subgen 81

L

Lagena sulcata apiculata 2 29
aspera 19
asperoides 2 19
globosa 22
marginata 23
orbignyana caribaea 22
semistriata 2 19
strumosa 2 20
ventricosa 43
vulgaris 19
Lagenonodosaria monilis 3 18
Lagunites n. gen. 85
Lenticulina occidentalis
novangliae 1 11
convergens 20 129
cornellina 21 129
rotulata 129
theta 1 11
Lepidocyclina crassata 18 125
gardnerae 7, 8 60
gigas 18 125
parvula 18 125
undosa 18 125
Leptodesma becki 43 187
carinifera 45 196
cornelli 46 198
disparile 43 186
mentor 42 191
mentor alpha 45 195
mentor biton 43 192
mentor maclurii 43 193
mentor maxima 44, 45 195
mantor rude 42 192
mentor sulcata 44, 45 193
mytiliforme 45, 61 187
parallelum 58 197
potens 42 187
potens juvens 42 187
ruedemanni 44 196
stephani 43 188
umbonatum depressum 43 188
Levifusus mallicus 15 92
Lingula cuyahoga 31 147
delia 31 147
ligea 31 147
scutella 31 146
waverliensis 31 147
Lingulina sp. 3 23
mesonensis 18 131
Lingulodiscina pleurites 31 147
Lucina corbula 9 74
Lyriopecten alternatus 56 183
fasciatus 55 183
solox 54 183

M

Mangelia jabonillalensis 15 90
Marginulina sp. 1 12
mesonensis 19 130
mexicana 19 130
Morgana costata 14 84
Morrey, Margaret, co-author of Bull. 55 1
Meson formation, forams of 123
Misilus 24
Modiola (Mytilops) metella 59, 63 215
praecedens 23,38 214
Modiomorpha quadrula 64 215
rigida 64 215
Mytilarca chemungensis 70 213
gibbosa 60, 62 214
lata 59 214
occidentalis 60 214
regularis 59 213

simplex 59 214
Mytilus gilbertharrisi 8 62

N

Nautilus comatus 13
Nerita standichenkiae 12 77
Nodosarella camerani 6 41
paucistriata 6 42
Nodosaria sp. 1 15
Nodosaria acuminata 1 14
adolphia 2 16
annulifera 2 17
arundinea 1 16
calamus 16
camerani 41
consobrina 1 15
conspurcata 2 18
emaciata 1 15
ewaldi 130
filiformis 130
holserica 2 17
laevigata 12
lepidula 2 17
longiscata 20, 21 130
monilis 18
obliqua 14
obliquestriata 1 14
pyrula 1 16
vertebralis 1 14
Nonion advenus 19 132
pompilioides 6 43
scaphus mesonensis 19 132
Nonionina advena 132
bulloides 43
pompilioides 43
quinqueloba 6 46
Nucula globularis 57 216

O

Oleanella n. gen. 205
Oleanella expansa 49, 51a 205
expansa gamma 51a 206
Olsson, A. A., author of Bull. 57 on Peruvian Molluscs, p. 67
Operculinella sabinensis 8 62
Orbiculoidea sp. 31 148
allegania 31 147
Orthis impressa, see Schizophoria
leonensis 29 150
Orthoceras bipartitum 71 235
cochleatum 71 235
leander 70 235
warrenense 71 235
Orthothetes crenistria 37 149
Ostrea quiroga 10 72
restensensis 10 72

P

Paleanatina angusta 62, 66 229
sinuata 60 230
solenoides 60 230
typa 61, 62 229
Paleoneilo elongata 60 216
Paracyclas erecta 66 227
ignota 57 227
pauper 57 227
Paraphorhynchus girtyi 30 165
medialis 32 163
Pegasella n. gen. 199
Pegasella ales 46a 199
Pararca equilateralis 63 226
erecta 63 224
neglecta 58 222
sao 58 223
transversa 63 225
venusta 58 222
Peruficus n. gen. 91
Peruficus lagunitensis 16 92
Peruvian Molluscs, see Bull. 57 p. 67. et seq.
Phacoides conventus 11 75
Phthonia nitida 60 229
truncata 60 229
Planispirina celata 8
Planulina affinis 4 32
Platyceras breve 67 232
dorsale 67 232
inequale 67 233
mitelliforme 67 233
ruedemanni 69 234
striatum 67 232
varians 67 233
Plectofrondicularia miocenica 5 37
Pleurostomella alternans 6 40
eoceana 40
Pleurotomaria sp. 69 234
Polymorphina gibba 132
Polystomella sagra 132
Prestwichia randalli 80 240
Prismodictya allegania 74 237
choanea 74 237
conradi 73 237
prismatica 74 237
Productella acutirostrata 40 168
bialveata 40, 41 169
boydii 41a 167
costatula 40, 41 168
hirsuta 41a 166
hirsuta rectispina 40 167
lachrymosa 40, 41 167
lachrymosa lima 40 167

lachrymosa stigmata 40, 41 167
onusta 40, 41 169
speciosa 40 168
striatula 41a 168
Prorhynchus angulatus 58 202
harrisi 44 202
nasutum 58 204
paeneplanus 44 203
quadratus 56, 61 201
Prothyris exuta 60 228
Protolimulus eriensis 76 241
Pteriopecten suborbicularis 55 183
Pteronites profundus 67 200
rostratus 67 200
Ptychopteria alata 47, 48, 49 210
beecheri 47, 48, 50 211
elongata 211
eucrate 47, 48, 49 211
eudora 211
falcata 50 210
galene 50 210
gibbosa 50 209
lobata 50 209
obsoleta 58 212
perlata 50 210
proto 49 208
salamanca 51 209
sao 46, 49, 51 212
sinuosa 49 208
spatulata 47, 48, 50 211
spio 212
thalia 50 210
thetis 212
trigonalis 48, 49 210
vanuxemi 50 209
Pullenia bulloides 6 43
quinqueloba 6 44
Pulleniatina obliquiloculata 20 136
Pulvinulina bryamensis 34
canariensis 25
umbonana 26

Q

Quinqueloculina angusta 3 8

R

Raphanulina 24
Reticularia praematura 32 181
Retzia sp. 32 156
Rhadinchthys sp. 78 248
Rhinoclavis 84
Rhipidomella leucosia 37 150
pennsylvanica 38 150
Rhynchospirina scansa 32, 34 181
Rhynchospirina sp. 182
Robulina deformis 21
Robulus calcar 2 20
deformis 2 21
duracina 2 21
midwayensis 19 128
taettowata 2 21
Rotalia advena 3 25
canariensis 25
ecuadorensis 3 26
haidingeri 30
nitidula 27
soldanii 27
umbonata 4 26
ungeriana 31

S

Sagenodus sp. 79 248
Sanguinolites subtruncatus 64 231
undulatus 64 231
Schizodus rhombeus 64 227
chemungensis quadrancuneus 64 228
gularis 64 227
oblatus 64 228
Schizophoria striatula 38 151
Schuchertella chemungensis 36 148
Sigmoilina celata 3 8
Siphonina advena 21 134
Siphoninella bryamensis 20 134
Sphaeroidina bulloides chilostoma 5 32
Sphenotus arcuatus 65 218
clavulus 63, 65 218
contractus 63, 65 218
palmerae 63 219
signatus 65 219
Spirifer allegheniensis 25 172
disjunctus 23, 24 169
Spirodomus insignis 80 224
Spiroloculina calata 8
Strombus buhrinus 13 90
Strophalosia histricula 41 149
muricata 37 149
Stropheodonta demissa 36 151
Stylonurus beecheri 76 240
Surcula occidentalis 15 94
Syringothyris angulata 27, 28, 29 174
randalli 174

T

Telescopium peruvianum 85
Textularia candeiana 19 127
flabelliformis 5 35

gramen 20 127
subhaueri 128
Thinopus antiquus 80 249
Thysanodictya expansa 72 238
randalli 72 238
Triloculina angusta 8
Tropidocaris alternata 80 239
bicarinata 80 239
interrupta 80 239
Truncatulina alleni 29
americana 136
elongata 137
haidingeri 30
lobatula 137
nucleata 31
pseudoungeriana 137
tenera 26
ungeriana 31
wuellerstorfi 31
Turricula bonilla 16 100
Turritella anceps 78
negritoensis 12 79
Tylodictya warrenensis 74 238

U

Uvigerina alata 6 38
beccari 6 38
bryamensis 19 133
hispida 6 39
mesonensis 133
proboscidea 6 39
pygmaea 6 39

V

Venericardia planicosta
labraensis 11 73
talara 11 74
Vernuelina cyclostomata 5 33
Virgulina bramletti 5 37
compressa 19 133

W

Woodsalia n. subgen 79

End of Volume XV

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